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electronics

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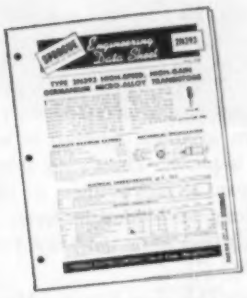

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For complete engineering data sheets of the types in which you are interested, write Technical Literature Section, Sprague Electric Co., 35 Marshall St., North Adams, Massachusetts.

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Chances are you'll pay top price for it. But by following these six rules you can avoid the high cost of becoming an inventor!*

IT'S natural to assume that, after designing a piece of equipment, you'll have no trouble finding standard fasteners to fit it. Usually such fasteners will be readily available. But what happens when you find yourself with a finished design that doesn't lend itself to any known fastening method?

The most expensive thing you can do at this point is to start inventing fasteners. Valuable man hours go into research, design, prototypes and testing. And unless you can make these fasteners in very large quantities the unit cost will be high, particularly if tooling is necessary.

Now, here are six tips that can get you out of trouble—and keep you out:

1. Remember—not all standard specialty fasteners are listed in fastener manufacturers' catalogs. The fastener company that serves you is probably tooled up for hundreds of non-standard devices, designed and produced to solve problems like yours for other customers. Maybe one would meet your requirements. You'd save the development and tooling charges.

2. There may be a stock fastener available for this job that hasn't come to your attention. Discuss the problem with the fastener manufacturer. If he has nothing in stock, he may be able to modify one of his standard devices at very nominal extra cost.

3. Don't overlook free professional help! Your fastener manufacturer will be glad to offer advice and design service—he does it for everyone else. Unload the problem on him, and let his experience work for you.

But you'll save money if you avoid specifying the fastener that hasn't been invented. By following the next three rules you can usually keep from reaching the point where a non-standard device might be necessary.

4. Go into the fastening problem during the early stages of design. Design your closures with standard fastenings in mind. You won't be left with the costly choice of inventing a fastener or redesigning your product.

5. Keep a complete file of fastener manufacturers' catalogs. Your product designers seldom are fastener specialists too, but they can have complete information available when they need it—at the design level.

6. Work closely with the Fastener Sales Engineer who calls on you. He's trained and paid to help solve your problems. Take full advantage of this service.

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This NEW FCR100—latest addition to the Sorensen line of Frequency Changers—supplies a frequency range from 45 to 2000 cycles with exceedingly good wave form, and matches the other Sorensen Frequency Changers in uniformly excellent performance.

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FCR100
Input Freq.: 45-65 cps
Output Freq.: 45-2000 cps
Out. Freq. Regulation: ±1% or ±0.01% with suitable external standard
Load Range: 0 to 100 VA.
Input Voltage: 105 to 125 VAC
Output Voltage: 115 nominal VAC
Harmonic Distortion: 1% maximum
$530.— in cabinet.

FCR250
Input Freq.: 45-65 cps
Output Freq.: 320-1000 cps
Freq. Reg.: ±1.0%; or ±0.01% with optional internal frequency standard
Load Range: 0 to 250 VA (500 VA at 400 and 800 cps)
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Voltage Reg.: ±1%
Harmonic Distortion: 5% typically
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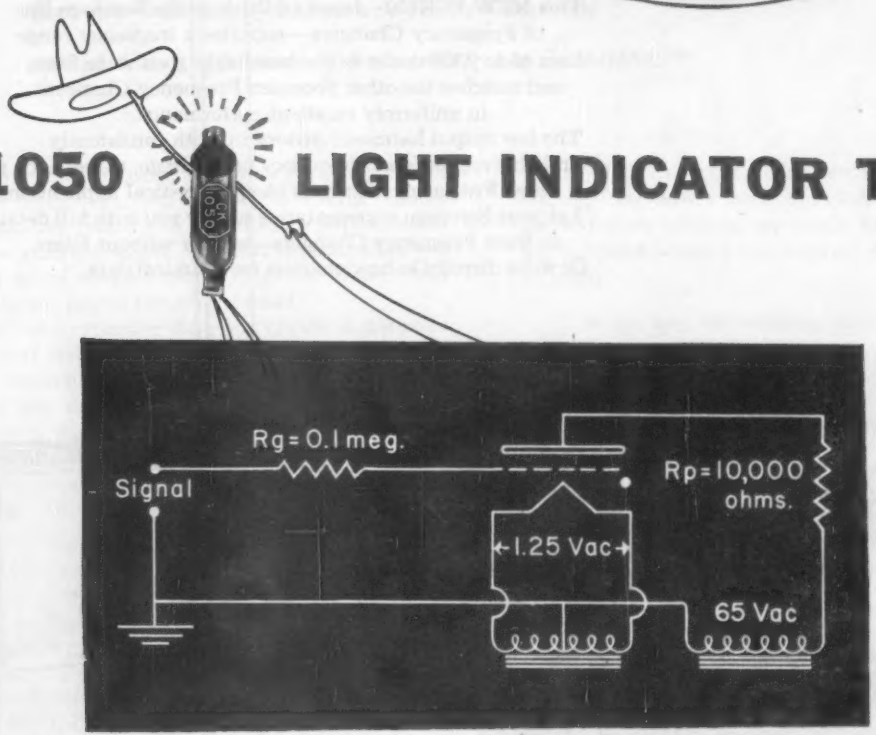
ride herd on transistor circuits

standardize on RAYTHEON

CK1050 LIGHT INDICATOR TUBES



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With above Circuit Conditions	
Average anode current	2.0 mAdc
Grid bias for conduction	0 to −3.1 Vdc
Grid bias for conduction (R_g = 2.0 meg)	0 to −4.1 Vdc
Average tube voltage drop at I_p = 5 mAdc	18 Vdc

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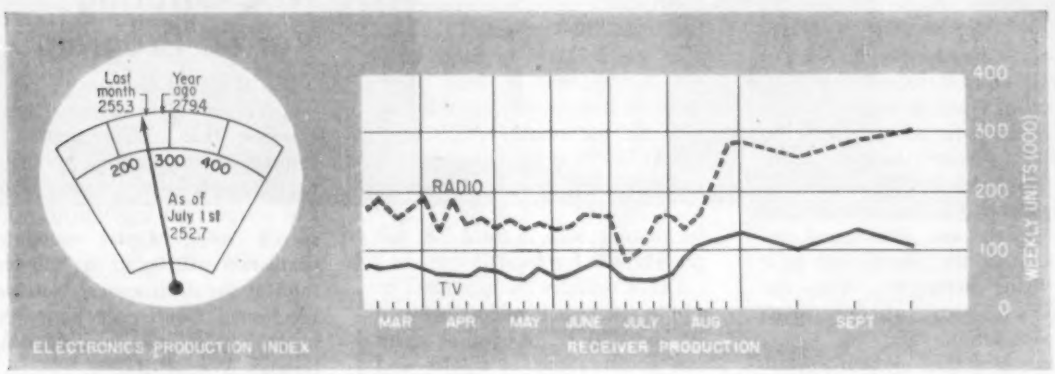
ELECTRONICS NEWSLETTER

CIVIL AVIATION ELECTRONICS battle may occur between U.S. and British representatives when the International Civil Aviation Organization meets in Montreal in February to discuss short-range navigation aids and their relationship to an international system. The British, whose long-range Dectra (Decca Navigator Co.) navigation system spans the Atlantic from Newfoundland to Scotland, are expected to push for a world air navigation standard embracing both VOR and Decca, the medium-range system of Decca Navigator. U.S. policy has been to support the VORTAC/DME system.

- In the New York area, helicopter navigation system evaluation for the Airways Modernization Board has seen the participation of Bendix Aviation, which produces the British gear and sells it in North America under the name Bendix-Decca, as a licensee of Decca Navigator.
- In Washington and then in Indianapolis last week, 23 nations sent representatives to a symposium on VORTAC and its relationship to an international air navigation system. Air Coordinating Committee was sponsor.

SEISMOLOGISTS of Columbia University have announced the detection of surface waves from nuclear explosions more than 7,000 miles away. Announcement was possible because the Atomic Energy Commission recently declassified precise times and locations of 10 nuclear explosions in the Marshall Islands in 1954 and 1956. Seismographs at Columbia's Lamont Geological Observatory, Palisades, N. Y., recorded surface waves from the Marshalls blasts. University scientists said such waves "presumably may be detected by long-period seismographs throughout the world." East-West delegates at Geneva recently reached an understanding on methods for detecting and identifying nuclear explosions which included seismic wave recording.

CIVIL AERONAUTICS ADMINISTRATION has just announced award of a $1,632,638 contract for scan conversion systems equipment to Intercontinental Electronics Corp., Mineola, N. Y., an affiliate of Cutler-Hammer. Intec says gear is capable of transforming radar, video map and beacon information into television information and displaying it on indicators that operate in normal ambient light. First installation is slated for New York's International Airport by late December. Each installation consists of two systems: System A, which has five scan conversion units, one control rack assembly, five horizontal consoles, four sector monitors and five maintenance monitors; and System B, which has two scan conversion units, one control rack, three horizontal consoles, four sector monitors and two maintenance monitors.



FIGURES OF THE WEEK

RECEIVER PRODUCTION

(Source: EIA)	Sept. 19, '58	Sept. 12, '58	Sept. 20, '57
Television sets, total	118,811	145,289	155,751
Radio sets, total	309,962	295,249	356,290
Auto sets	109,901	89,210	105,965

STOCK PRICE AVERAGES

(Source: Standard & Poor's)	Sept. 24, '58	Sept. 17, '58	Sept. 25, '57
Radio-tv & electronics	59.48	59.10	44.99
Radio broadcasters	69.12	69.22	56.43

FIGURES OF THE YEAR

Totals for first seven months

	1958	1957	Percent Change
Receiving tube sales	221,201,000	254,252,000	—13.0
Transistor sales	21,084,218	12,902,300	+63.4
Cathode-ray tube sales	4,239,404	5,306,594	—20.1
Television set production	2,442,929	3,082,799	—20.8
Radio set production	5,582,834	7,799,882	—28.4
TV set sales	2,456,662	3,236,697	—24.1
Radio set sales (excl. auto)	3,452,833	4,236,453	—18.5

Airways Modernization Board officials get ready to

Test 'Copter Systems

Keeping track of helicopters presents problems. Here are a few possible answers

OPERATIONAL TESTING of the Bendix-Decca low-frequency navigation system aboard five New York Airways helicopters began last month under Airways Modernization Board sponsorship.

The tests are an attempt to loosen one more knot in the tangled skein of civil air navigation and traffic control. Right now, installation and pilot familiarization have been completed. Six months of data-taking will follow. No firm results are expected before 1961.

Medium-range navigation by the VORTAC system, ideal for fixed-wing aircraft, isn't good for the whirlybirds. The system's vhf and uhf signals are interrupted by obstacles in the line-of-sight to a low flying helicopter. Also, the 'copter's rotor can introduce spurious modulation.

Helicopters also present special traffic control problems. Bobbing up and down behind obstacles, they are hard to spot on airport surveillance radars. One answer is to keep them on precisely defined aerial highways and keep fixed-wing aircraft out of their way.

AMB has contracted with four firms to check out the Decca system as a medium-range navigation aid for helicopters: Pacific Division of Bendix has installed a four-station Decca chain of transmitters and seven of the 108-lb mobile units. Five are in NYA commercially scheduled helicopters. Bendix got $175,000 in fiscal 1958, will get $175,000 in fiscal '59.

Bell Helicopter has supplied AMB with a specially instrumented helicopter. Bell's share of the contract was $50,000 in fiscal 1958, will be $52,000 in fiscal 1959. Airborne Instruments Lab will evaluate the test results. AIL's share was $163,000 in the last fiscal year and is $90,000 in the present one. N. Y. Airways came in for $82,000 for running tests in fiscal '58, will get $82,000 for fiscal '59.

Decca operates on harmonics of a 14-kc reference frequency between 70 and 130 kc. A typical chain uses four stations: a master and three slaves. Each slave is about 70 miles from the master. Phase comparisons of incoming signals fix position on a hyperbolic grid. A flight plotter on the airplane's instrument panel has a stylus that traces out the flight pitch on a special area map. Aircraft position always corresponds to the spot directly under the stylus. Use of Decca system for helicopter navigation is also under study by the Army at Fort Huachuca, Ariz., and in Western Germany.

Medium-range navigation is not the only helicopter requirement now receiving attention. AMB's Bell H-13H helicopter is equipped with a pictorial crossed-pointer instrument landing aid. The device, known as RAILS (Remote Area Instrument Landing System) includes Sylvania's APN-117 radar altimeter, a computer to convert Decca's hyperbolic position coordinates into crossed-pointer indication, a drift indicator and a sensitive air-speed indicator. An additional helicopter landing aid, a 65-lb X-band radar set with 360-deg scan, has been used experimentally by the Marines. Radar was developed by Bendix.

A sonic altimeter, also designed by Bendix, has been tried out in helicopters. The device operates on 14 kc. It requires 25 w from a transistor power supply and delivers 10 w audio power into a microphone with 10 to 12 percent efficiency. The altimeter is reportedly accurate to 3 in. at an altitude of 250 ft. Major developmental problem has been interference from ambient sonic noise.

NEC Offering Varied Program

CHICAGO — LAST-MINUTE developments on space stations, satellites and their instrumentation, a tutorial session on automatic navigation, talks on network theory and a report on experiments with speech using digital computer simulation will be among top features at the 14th annual National Electronics Conference here next week. The meeting runs Monday through Wednesday.

Featured speakers include Gen. John B. Medaris of Redstone Arsenal, Deputy Secy. of Defense Donald A. Quarles, and Simon Ramo of the Ramo-Wooldridge Corp.

The special IGY technical session has as speakers Allen M. Peterson, Stanford University;

(Continued on p 12)

STANDARD MISSILE GROUND CHECKOUT AND LAUNCHING "DC POWER SUPPLIES"

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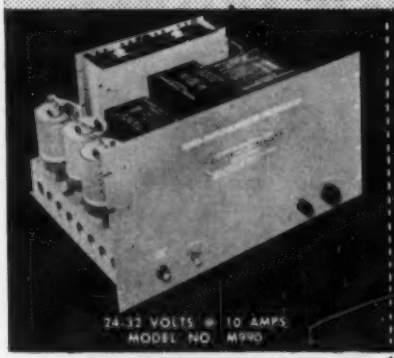
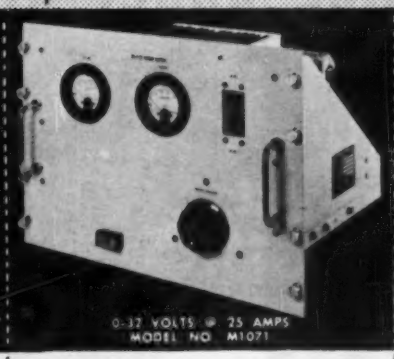
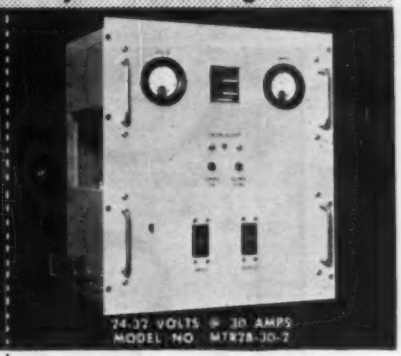
PROVEN in production use in the Nation's Major Missile Programs



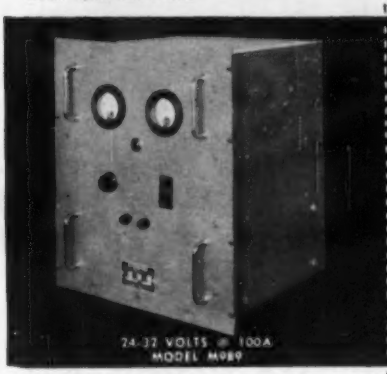
Transistor—Mag amp power supply
DC Output: 24-32V @ 10 amps
AC Input: 105-125V, 1 phase, 60 cps.
Static Regulation: ±0.1% line & load
Dynamic Regulation: ±0.1% line; ±1% load
Ripple: 1 MV R.M.S. maximum
Output Impedance: 0.05 ohms, 0-20 KC
Protection: Short circuit proof; unit has automatic current limiting at 125% of rated load
Dimensions: 19"W x 10½"H x 15"D rack panel mount
Meets Spec. MIL-T-4860



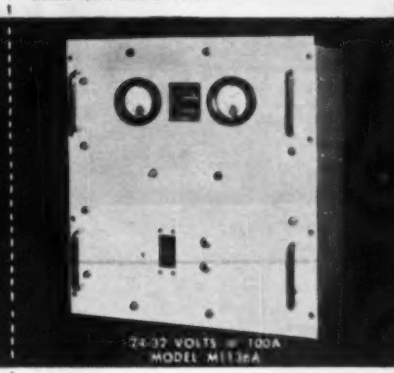
Mag-amp power supply
D.C. Output: 0-32V @ 25 amps (Surge loads to 35A for 30 min. or less)
A.C. Input: 115V, 1 phase, 60 cps.
Regulation: ±1% 28 volts— Not stabilized for A.C. line voltage changes.
Ripple: 1% RMS @ 32V and full load
Response Time: 0.1 to 0.2 seconds
Dimensions: 19"W x 14" H x 15"D Rack panel mount
Meets Spec. MIL-E-4158A



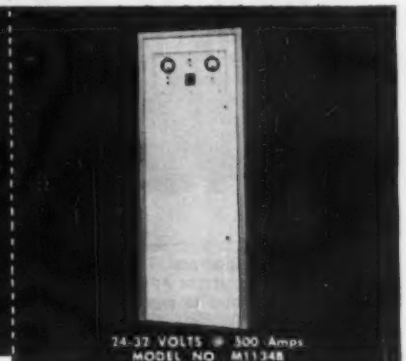
Transistor—Mag amp power supply.
D.C. Output: 24-32V @ 30 amps
A.C. Input: 105-125V, 1 phase, 60 cps
Static Regulation: ±0.1% line and load
Dynamic Regulation: ±0.1% line ±1% for full load changes
Ripple: 7 MV RMS max.
Output Impedance: 0.05 ohms 0 to 20 KC
Protection: Short circuit proof; unit has automatic current limiting at 125% rated load
Dimensions: 19"W x 21¼"H x 14"D Rack panel mount
Meets Spec. MIL-E-4970



Mag-amp power supply
D.C. Output: 24-32V @ 100 amps
A.C. Input: 208/230 or 460V ±10% 3 phase, 60 cps
Regulation: ±½% for line & load
Ripple: 1% RMS
Response Time: 100 milliseconds
Dimensions: 19"W x 21"H x 16"D Rack panel mount
Unit incorporates remote sensing.
Meets Spec. MIL-E-4970



Transistor—Mag amp power supply.
D.C. Output: 24-32V @ 100 amps
A.C. Input: 208V ±10%, 3 phase, 60 cps.
Static Regulation: ±0.1% line, ±0.2% for load
Dynamic Regulation: ±0.5% line, ±2V. for full load changes
Ripple: 10 MV RMS max.
Dimensions: 19"W x 21"H x 18"D Rack panel mount
Meets Spec. MIL-E-4970



Transistor—Mag amp power supply
D.C. Output: 24-32V @ 500 amps
A.C. Input: 208/230/460 V ±10% 3 phase, 60 cps
Static Regulation: 0.1% line; 0.1% load
Dynamic Load Regulation: ±15% for full load changes
Ripple: ½% RMS max.
Response Time: Adjustable 20-200 MS
Dimensions: 26"W x 68"H x 32"D
Meets Spec. MIL-P-6457A

For further data, contact Perkin Factory or Sales Offices.

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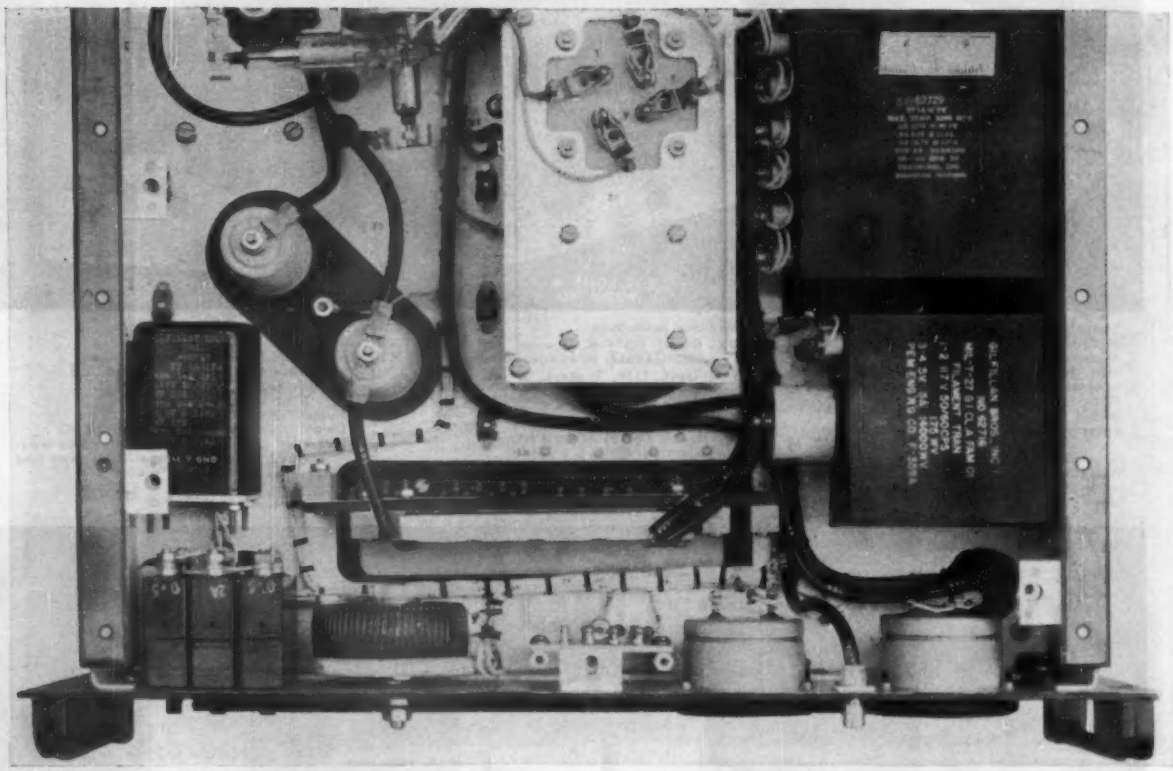
Design better products with

SILICONE-GLASS LAMINATES

...resist arcing under high voltage



This AN/FPN-33 Quadradar Transmitter of Gilfillan Bros., Inc., of Los Angeles, employs silicone-glass laminates to prevent recurrent arcing under high voltage and high humidity conditions. Gilfillan Bros. also use silicone laminates in their Ground Control Approach equipment.

TYPICAL PROPERTIES OF SILICONE-GLASS LAMINATES*

Flexural Strength, psi	
at 25C	24,000
at 260C after 100 hr at 260C	4,600
Water Absorption, percent	0.05
Electrical Strength, volts/mil	
initial	310
after 200 hr at 260C	327
after 5000 hr at 260C	180
Dielectric Constant at 10^6 cycles	
Condition A[1]	3.67
Condition D[2]	3.68
Dissipation Factor at 10^6 cycles	
Condition A[1]	.002
Condition D[2]	.004

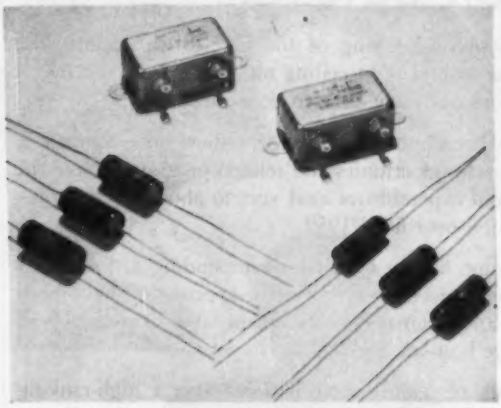
* As measured on samples 1/8 inch thick.
[1] As received.
[2] After 24 hr immersion in water at 23C.

Silicone-glass laminates are ideal dielectrics for high voltage electronic devices operating under extreme humidity conditions. Made of glass cloth bonded with Dow Corning silicone resins, these laminates have high arc resistance, low moisture absorption, low loss factor. At temperatures as high as 250 C, they retain excellent physical and dielectric properties. Lightweight yet strong, silicone-glass laminates are easy to fabricate and machine. Supplied as tubes, sheets, and punched or molded parts by leading laminators. Write for FREE BOOKLET.

first in silicones

Dow Corning CORPORATION
MIDLAND, MICHIGAN

Dow Corning Silicone Dielectrics

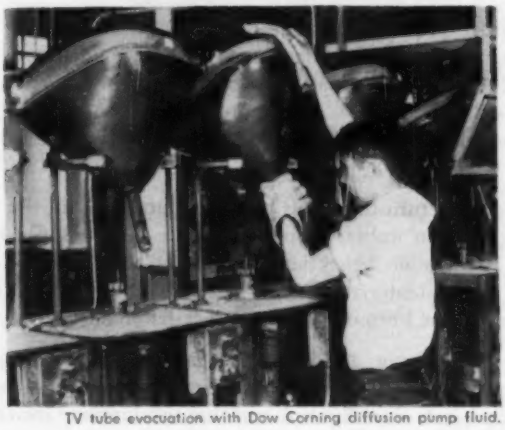


Aerovox capacitors impregnated with silicone dielectric fluid.

SILICONE DIELECTRIC FLUIDS IMPROVE COMPONENT CHARACTERISTICS

A liquid dielectric, Dow Corning 200 Fluid makes higher operating temperatures possible, increases stability, aids miniaturization and improves characteristics of electronic assemblies and components. Silicone fluid impregnated capacitors, for example, maintain near-constant capacitance at high and low temperatures, show little change in properties over a wide range of frequencies and environmental conditions.

CIRCLE 104 READERS SERVICE CARD



TV tube evacuation with Dow Corning diffusion pump fluid.

SILICONE DIFFUSION PUMP FLUIDS OFFER GREATER STABILITY, ECONOMY

Because of their great stability, Dow Corning silicone fluids make diffusion pump operation more efficient and economical. They develop vacua in the range of 10^{-5} to 10^{-7} mm of Hg; resist oxidation even when exposed to air at operating temperatures. Dow Corning diffusion pump fluids do not decompose into gums or tars . . . save replacement costs and production time. In addition, they offer rapid recovery and quick pumpdown.

CIRCLE 105 READERS SERVICE CARD

SILASTIC COVERED WIRE RESISTS CORONA, OZONE

Wire and cable insulated with Silastic®, the Dow Corning silicone rubber, is easy to strip and solder — flexible for quick and convenient hookup of electronic components. Unaffected by moisture, weathering and temperature extremes from −90 to 250 C, Silastic insulation remains flexible and retains its dielectric properties despite long exposure to corona and ozone. Wire insulated with Silastic is readily available from leading cable manufacturers.

High voltage transformer for RCA TV receiver.

CIRCLE 106 READERS SERVICE CARD

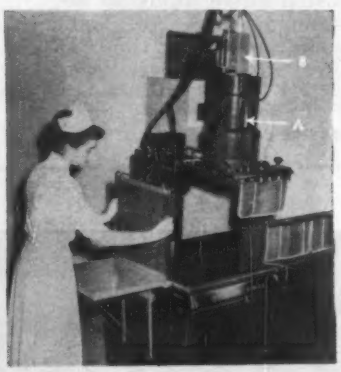
W. H. Pickering, Cal. Tech.; and Alan H. Shapley, Bureau of Standards, Colo.

In addition, panel discussions on "The Role of the Laboratory Program in Engineering Education" and "Engineering Writing and Speech" will be held. About 100 scientific papers in 24 different areas of electronics will be given by engineers and scientists from 16 states and three foreign countries.

Lawrence W. von Tersch, program chairman, tells ELECTRONICS that the "quality of the papers is extremely high, and the sessions concerning automatic navigation, network theory and speech using digital computer simulation are outstanding in their scope and interest."

A record number of more than 250 commercial exhibits, highlighted by displays of new electronic developments and devices, are scheduled. NEC officials expect more than 10,000 registrants, principally scientists, engineers, educators, manufacturers and government officials, will attend.

X-Ray Amplifier Cuts Exposure



New image amplifier (A) for x-ray equipment is readied for operating demonstration with closed-circuit tv camera (B)

NEW X-RAY image amplifier device being studied this week by medical men in the Chicago area is reported to produce projections 350 times brighter than conventional fluoroscope equipment.

Further advantage claimed for the amplifier is a substantial reduction in the total amount of radia-

WASHINGTON OUTLOOK

IN THE YEAR since Russia's launching of the first earth satellite, the defense budget has gone from a tight ceiling on spending, to a removal of expenditure restrictions and now back to economizing.

Defense spending has been boosted almost $3 billion since Sputnik I, with the biggest increases for electronics and related programs. Now the Pentagon is trying to hold expenditures next year to about $42 billion—a rise of roughly $1 billion over fiscal 1959.

This has generated some talk in industry of impending cancellations of contracts. Among the projects involved in the speculation have been Martin's Titan ICBM and Seamaster jet seaplane and Convair's B-58 supersonic medium-range bomber.

You can disregard talk of Titan's cancellation. Says a high-ranking Pentagon official: "Titan is a remarkably unlikely candidate for discontinuance. The very considerations which led us not to make Titan a crash project and thus indistinguishable from Atlas, now assure the continuance of the project."

However, in terms of scope, speed and direction, Titan project will still be under what program officers and contractors would like.

Odds are that the Seamaster project, which now lags about two years behind schedule, will be cancelled. Production of the B-58 will likely go beyond the 77 aircraft already ordered or planned, but output will be severely limited.

- **The Pentagon's return** to serious budget-economizing in the face of growing Russian military capabilities is a tremendously risky decision. There is no belief in Washington that the cold war threat has abated materially in the past year. Indeed, the crises in Lebanon and the Formosa Straits have caused renewed concern.

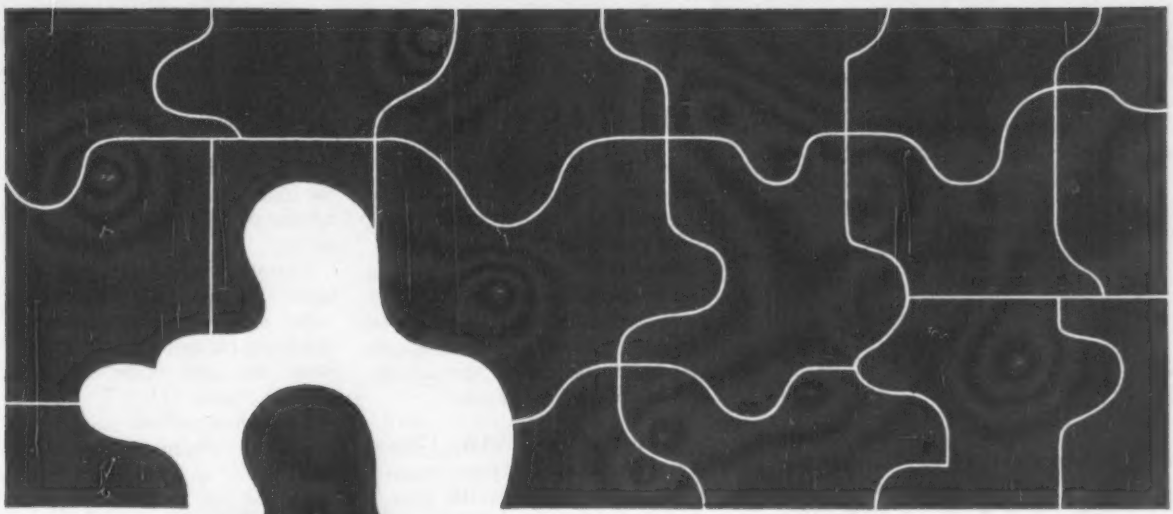
  But the Eisenhower administration is confident that great strides have been taken in the U.S. missile program and other key defense projects since Sputnik and that substantially increased expenditures would not necessarily bolster U.S. military power.

  This is how one top-level Defense Dept. official puts it: "We're tremendously stronger than we were a year ago. Whether our position vis a vis the Russians has improved, we don't know. But we certainly haven't fallen back any.

  "Our basic policy is still to deter an enemy from taking aggressive action. We believe we've got the power to do this now. That's why we haven't got into an all-out arms race with Russia."

- **Air Force contractors** will soon be getting the final version of the so-called "make-or-buy" regulations. These rules, as originally proposed, would have required prime contractors to stick by an initial "make-or-buy" list submitted to the Air Force. The list enumerated what items the prime contractor would make himself and what items he would buy from subcontractors.

  However, when the final version comes out, it won't be so rigid; primes will be allowed to change from make to buy or conversely by giving the Air Force prior notice. Air Force officials will have the last word. The new regulation applies to all contracts of $350,000 or more.



Puzzled by ground loop problems? How to rescue microvolt signals from volts of noise?

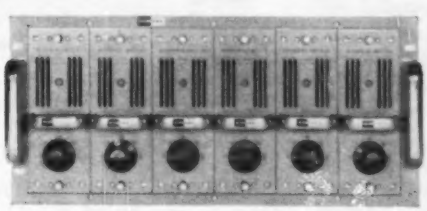
HERE'S WHY KIN TEL'S DIFFERENTIAL DC AMPLIFIERS FIT IN INSTRUMENTATION SYSTEMS

160 db DC, 120 db 60 cycle common mode rejection with balanced or unbalanced input ■ Input completely isolated from output ■ Input and output differential and floating ■ 5 microvolt stability for thousands of hours ■ .05% linearity, 0.1% gain stability ■ Gain of 10 to 1000 in five steps ■ >5 megohms input, <2 ohms output impedance ■ 120 cycle bandwidth ■ Integral power supply

These are just a few of the many outstanding features of the Model 114A differential DC amplifier . . . features that make this amplifier *really work* in instrumentation systems...features that will help solve *your* instrumentation problems today.

Ideal for thermocouple amplification, the 114A eliminates ground loop problems; allows the use of a common transducer power supply; permits longer cable runs; drives grounded, ungrounded or balanced loads, and can be used inverting or non-inverting.

For additional information and technical literature on this exceptional instrument, write or call KIN TEL – the world's largest manufacturer of precision, chopper-stabilized DC instruments.



KIN TEL 114A differential DC amplifiers ...convenient, interchangeable plug-in mounting in either 6-amplifier 19" rack mount modules or single-amplifier cabinets.

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KIN TEL
A Division of Cohu Electronics Inc.

tion to which physician and patient are exposed during examination.

The new unit, produced by Rauland Corp., subsidiary of Zenith Radio, has a 41-sq in. screen.

Aimed primarily at cardiological use, the bright image and large screen area permit a good view of the entire human heart and surrounding area. Also possible are examinations of the complete stomach or colon while radio-opaque barium salts are moving through.

Higher image brightness suggests the possibility of viewing x-ray patients by closed-circuit tv from another room where radiation exposure is eliminated and consultations are possible, say researchers.

Study Printed Cryotron Circuits

OF SPECIAL INTEREST to electronics engineers is a progress report on the cryotron, presented recently by Dudley A. Buck of MIT. Cryotron, a superconducting electronic switch for digital computers, operates on principle of magnetic destruction of superconductivity.

Cryotron, developed by Buck and now undergoing further work at MIT and at A. D. Little, Inc., is used in circuits refrigerated by liquid helium.

Subminiature device comprises a single straight wire around which a wire coil is wrapped. Straight wire conducts current with zero resistance. Current in control winding can quench superconductivity in straight wire and resistance returns. Interconnection of cryotrons provides basic computer switching circuits.

Buck reported 23 elements are known to have superconductive properties at low temperatures. Work at MIT is concentrating on tantalum and tin, with niobium used for control windings.

Slow switching speed is cryotron's drawback. Since speed increases as size decreases, MIT group is attempting further miniaturization by techniques analogous to printed circuits, with elements as well as wires printed. A new type of electron-beam photography is under study for printing cryotron circuits.

MILITARY ELECTRONICS

• **Navy has four Vanguards** left to shoot and says it will fire them between now and the end of the IGY this Dec. 31. Although Vanguard has been successful in putting only one grapefruit-sized satellite into orbit after eight attempts, the system, technically speaking, is considered to be one of the nation's most sophisticated missiles.

• **First of twin 90-ft,** 150-ton radio astronomy antennas, recently hoisted into place in the Owens Valley, Calif., desert, will be ready for listening this month. The second will be operational by Dec. They will be hooked up for use together by Spring.

The $1.5-million installation is being financed by the Office of Naval Research and will be operated by the California Institute of Technology.

To lower wind resistance and let the rain through, the 6,000 sq ft of steel mesh sheeting is perforated by ⅜-in. holes. The reflecting skin of the dish can be adjusted on its tubular steel frame at 324 different points.

Mounted on wheels that ride tracks 35 ft apart, a 1-hp electric motor is used to aim the antennas. Operating on only a fraction of its power, the same motor is used to track the stars.

Research objectives include attempts to identify several hundred radio sources with visible stars. "So far," scientific director John G. Bolton says, "only about 50 of some 2,000 known radio stars have been identified."

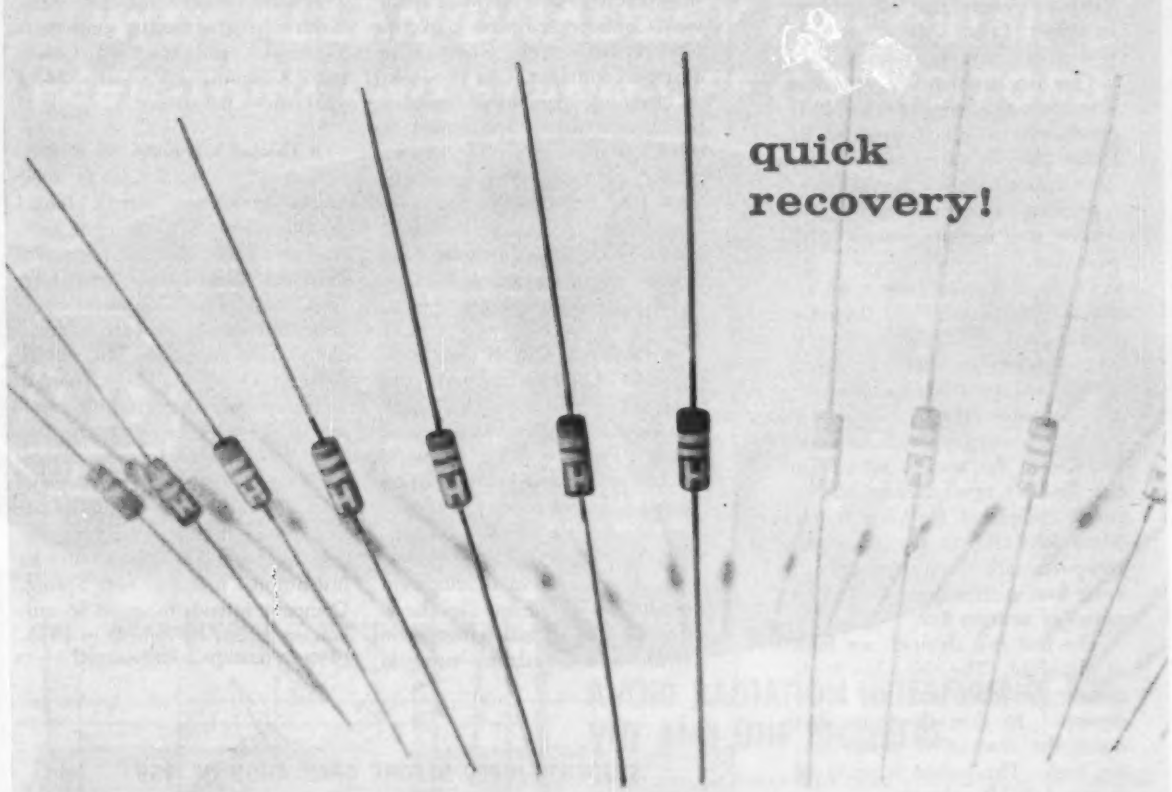
Some benefits to be derived from the work, Navy says, are: advances in electronic techniques such as low-noise receivers and antennas, and better knowledge of the propagation of radio waves through the ionosphere and the troposphere. Wavelengths ranging from about two inches to near 40 in. will be studied.

One portion of solid-state system is built and wrapped up as . . . .

Magnetics Control Triton

MAGNETIC AMPLIFIERS form the active elements of the $1-million powerplant instrumentation system going into the *Triton* nuclear submarine. System will provide more than 75 continuous measurements of pressure, temperature, flow and level of coolants and feedwater.

The primary coolant loop contains 44 sensing elements linked to 78 measurement and control magnetic amplifiers. The ampli-



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Reliable Hughes Silicon Junction Diodes

With recovery to 400 K ohms (minimum) in 1 microsecond...Hughes high-speed silicon diodes reliably meet the quick recovery requirements of most germanium types, and in addition, stand up under high voltages at high temperatures. In fact, the breakdown voltages increase with temperature...thereby providing maximum protection when temperatures reach unexpected levels. With this order of reliability, Hughes quick recovery silicon diodes assure dependability under the most severe operating temperatures.

Typical performance levels:

Breakdown voltages at current of 0.1 mA from 30-200 volts.

Ambient operating temp. —80°C to +150°C
Reverse current—as low as 1 μA at —175 volts and 25°C
—as low as 30μA at —175 volts and 100°C

Special high conductance types in the quick recovery series are available in all voltage classes. No matter what your problem, chances are that there is a Hughes diode to meet your need. Write today for a complete data sheet on the Hughes quick recovery silicon diode —or any other Hughes semiconductor device.

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Creating a new world with ELECTRONICS

HUGHES PRODUCTS

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fiers, housed in six cabinets, transmit signals to 41 indicators and to control initiation and alarm circuits. The feedwater systems contain 32 sensing elements, 66 measurement and control amplifiers and 32 indicators.

The system, designed by General Electric's instrument department in West Lynn, Mass., contains several new sensing elements.

One is a resistance temperature detector with a range of 0 to 700 F. Another is a sealed pressure detector able to withstand one ton per square inch. Sensing and measuring elements are sealed within the nuclear reactor compartment.

In the feedwater system, an all-magnetic computer matches the steam demand of the turbine to reactor power according to a predetermined program and controls the feedwater valve.

Instrumentation which monitors and limits the nuclear activity in the *Triton*'s twin reactors was recently completed by Allen B. Du Mont labs. It is a special-purpose computer with three channels covering low, intermediate and power ranges of neutron flux.

The first two channels are built in duplicate. The third has triple circuitry for added safety and is also equipped to slow down or shut down the reactors if power rises too high. The system is packaged in two 1,000-lb cabinets.

17 Airlines Order New Jet Trainer

TWENTY-SIX-TON electronic flight simulator ordered by 17 airlines began teaching pilots to fly commercial jet transports this week.

The flight simulator (ELECTRONICS, p 16, Feb. 14) duplicates all flying conditions from takeoff to landing in a flight deck replica of the new Douglas DC-8. It provides instrument simulation, aircraft motion, and sound. It also provides a visual representation by closed-circuit tv of airport runways and surrounding terrain during approaches and takeoffs.

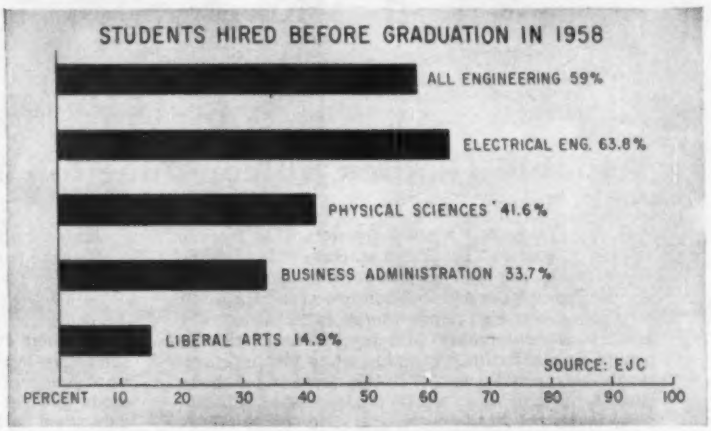
A 300:1 scale model of an airport is projected on a screen.

FINANCIAL ROUNDUP

• **Chemical industry,** one of electronics' major customers, should enjoy a 10 percent sales increase in 1959, a chemical industry spokesman predicted at a National Industrial Conference Board marketing meeting last month. Chemical industry accounts for 10 to 11 percent of electronic equipment spending by manufacturers. Spokesmen for other industries which are important electronics customers look for a 4 to 5 percent hike in petroleum sales, 25 percent for steel, and 20 to 30 percent in autos, 6 percent for machinery and equipment, and 5 percent for textiles.

• **Marquardt Aircraft** joins growing ranks of aircraft firms acquiring electronics divisions. The L. A. firm purchased assets of **Associated Missile Products Co.,** Pomona, Calif., a division of **American Machine & Foundry,** for slightly more than $1 million. Associated Missile Products Co. employs about 300 people in development and production of missile checkout and test gear, data transmission systems and simulators used in training aircraft personnel in radar operation. American Machine & Foundry will remain active in the electronics field. Firm's **Defense Products Group** still has three electronics engineering centers—in Greenwich and Stamford, Conn., and Alexandria, Va.—an AM&F spokesman points out.

• **Thiokol Chemical** offers 106,669 shares of capital stock to stockholders at $42 per share. Thiokol got in electronic equipment business in 1957 when it purchased **National Electronics Laboratory.** NEL, now part of Thiokol's **Specialties Division,** is presently engaged in development of vhf transmitter-receiver equipment, remote control units and electronic recording devices. Proceeds from stock issue will be used for general corporate purposes. Firm also plans to raise $7 million of additional new money through sale of 5½ percent long-term unsecured notes to institutional investors next Spring. Company intends to spend $6 million on capital equipment in 1958-1959.


STUDENTS HIRED BEFORE GRADUATION IN 1958
ALL ENGINEERING 59%
ELECTRICAL ENG. 63.8%
PHYSICAL SCIENCES 41.6%
BUSINESS ADMINISTRATION 33.7%
LIBERAL ARTS 14.9%
SOURCE: EJC
PERCENT 10 20 30 40 50 60 70 80 90 100

Electrical engineering led in pregraduation hiring in 1958. Survey shows . . .

EE Grads Soon Find Jobs

PLACEMENT SURVEY of 1958 engineering school graduates indicates that members of the 1959 class, now back at school, will have no difficulty finding jobs next spring.

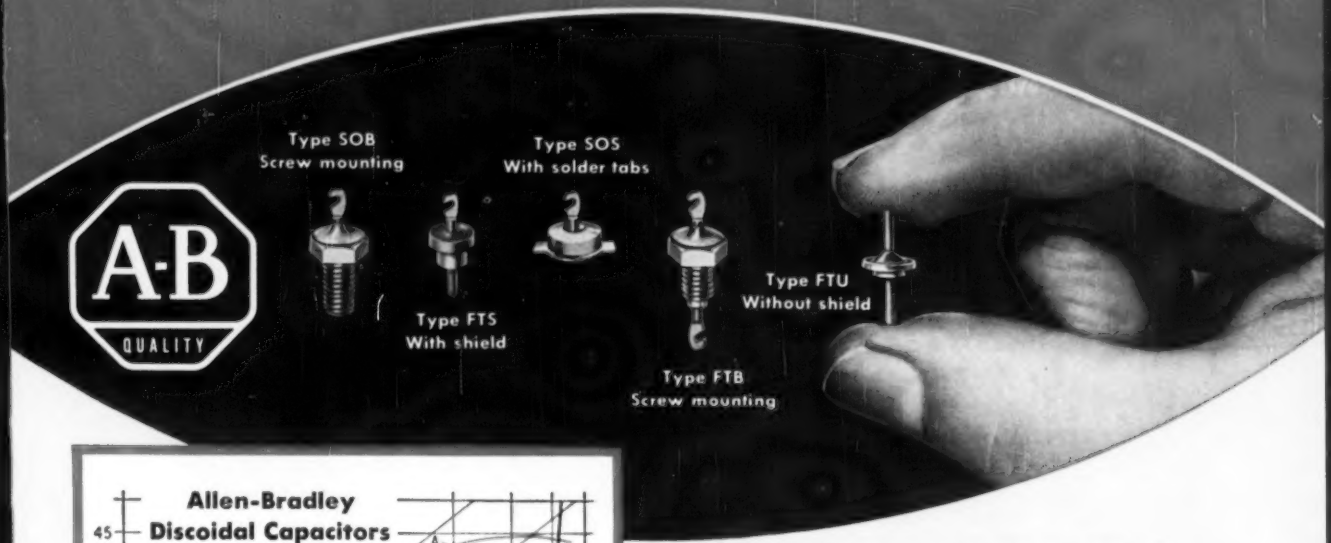
(Continued on p 20)

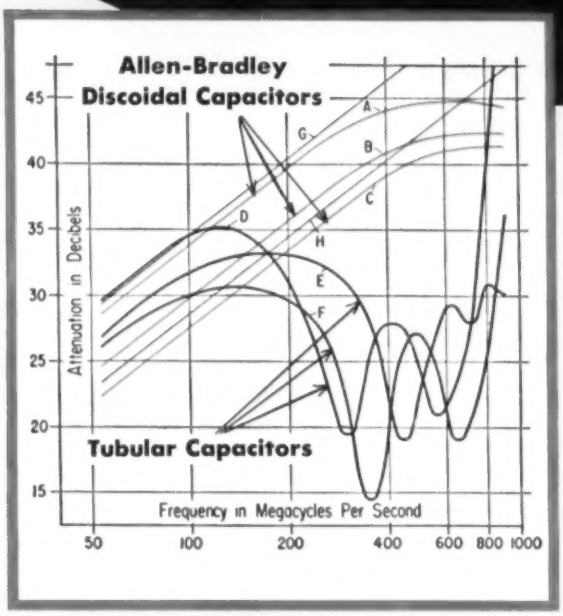
CIRCLE 10 READERS SERVICE CARD →

NO PARALLEL RESONANCE

(UP TO 1000 MEGACYCLES)

WITH ALLEN-BRADLEY DISCOIDAL FEED-THRU AND STAND-OFF CAPACITORS





Discoidal vs. Tubular Feed-Thru Ceramic Capacitors

Allen-Bradley Discoidal Type	Curve A—1800 MMF at 1 KC Actual Curve B—1150 MMF at 1 KC Actual Curve C— 800 MMF at 1 KC Actual
Representative Tubular Type	Curve D—2000 MMF at 1 KC Actual Curve E—1500 MMF at 1 KC Actual Curve F—1400 MMF at 1 KC Actual
The "Ideal" Capacitor	Curve G—2000 MMF Curve H—1000 MMF

AVOID RADIATION INTERFERENCE FOR VHF AND UHF RECEIVERS

Their unique discoidal design eliminates ALL parallel resonance effects which are normally encountered with tubular type capacitors in the VHF and UHF frequency ranges. With this complete absence of self-resonance, as shown in the graph at left, you can use far greater nominal capacitance values to obtain lower coupling impedances . . . and superior filtering.

The rugged construction of Allen-Bradley discoidal capacitors minimizes breakage during assembly or from thermal shock incurred during soldering. And, these capacitors have *gold plated* terminals to insure faultless soldering every time . . . even after long periods in storage.

Both feed-thru and stand-off capacitors are available in standard nominal capacitance values from 5 mmf to 1,000 mmf.

For suppression of stray radiation at frequencies to 1,000 megacycles, you cannot equal Allen-Bradley discoidal capacitors. Send for Technical Bulletin 5409.

ALLEN-BRADLEY
ELECTRONIC COMPONENTS
QUALITY

5-58-E

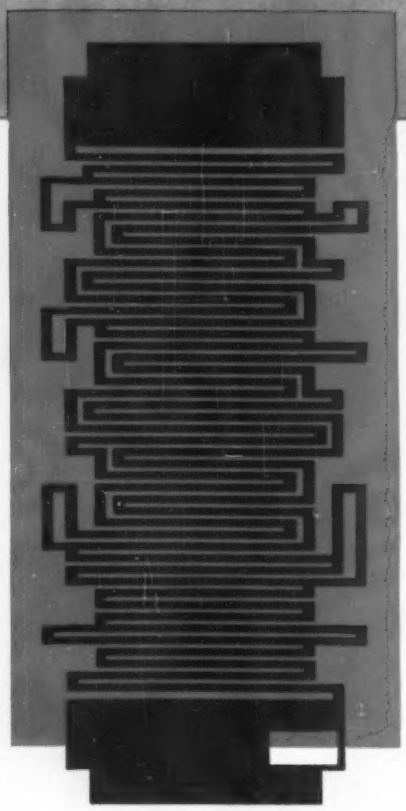
Allen-Bradley Co., 222 W. Greenfield Ave., Milwaukee 4, Wis. In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

ALLEN-BRADLEY PRESENTS...

NEW METAL GRID

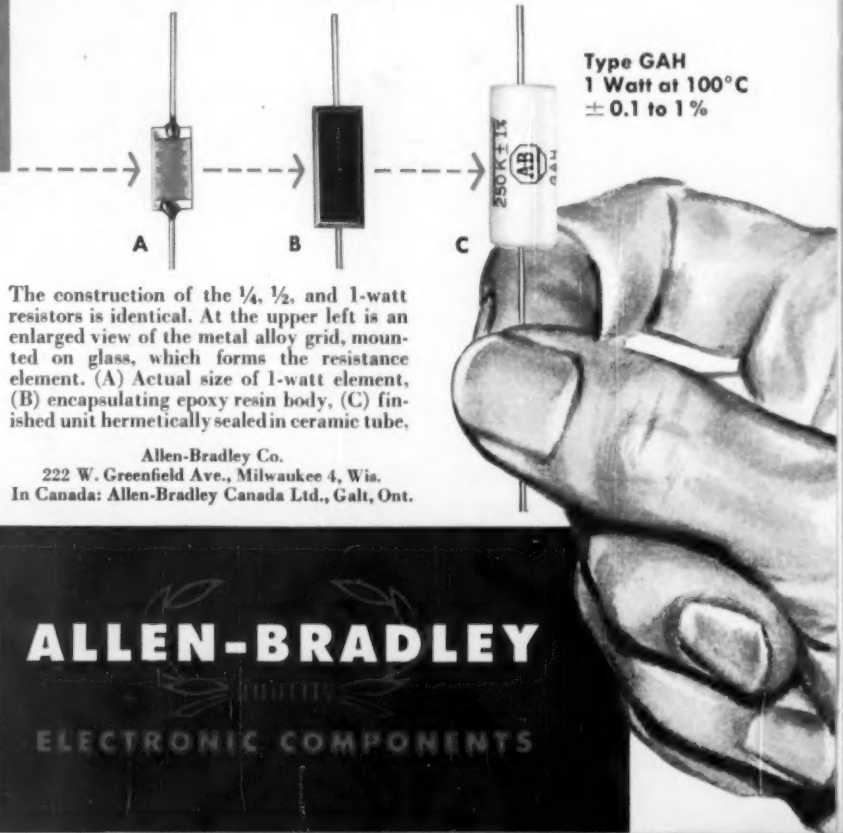
¼, ½, and 1-WATT

PRECISION RESISTORS

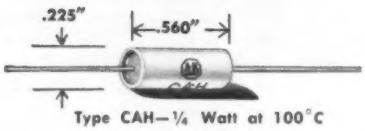


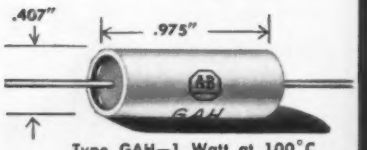
Far exceed MIL Specs for film and wire-wound resistors

Allen-Bradley's new, truly accurate, metal grid resistors are now available in ¼, ½, and 1-watt ratings, producing test results that are a substantial improvement over the MIL Specifications for wire-wound and film type precision resistors. They combine remarkable stability, under load and on the shelf, with an exceptionally low temperature coefficient. The metal alloy grid is noninductive, providing excellent high frequency characteristics. They also have an exceptionally low noise level . . . comparable to that of wire-wound units. Each unit is individually calibrated and marked with nominal resistance value, tolerance (± 0.1 to 1%), and temperature coefficient. Provided with gold plated leads for flawless soldering. Considering their superior characteristics, these new resistors justly qualify under the Allen-Bradley trademark of *Quality*.



The construction of the ¼, ½, and 1-watt resistors is identical. At the upper left is an enlarged view of the metal alloy grid, mounted on glass, which forms the resistance element. (A) Actual size of 1-watt element, (B) encapsulating epoxy resin body, (C) finished unit hermetically sealed in ceramic tube.





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Allen-Bradley Co.
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ALLEN-BRADLEY

ELECTRONIC COMPONENTS

At Ansco, America's prime contractors can make use of a vast supply of technological talent to help solve precision gear assembly problems quickly and easily.

Ansco has been manufacturing precision assemblies designed to do specialized jobs in the mechanical-optical fields and, of course, has research and development facilities to place at the disposal of anyone needing specialized talent.

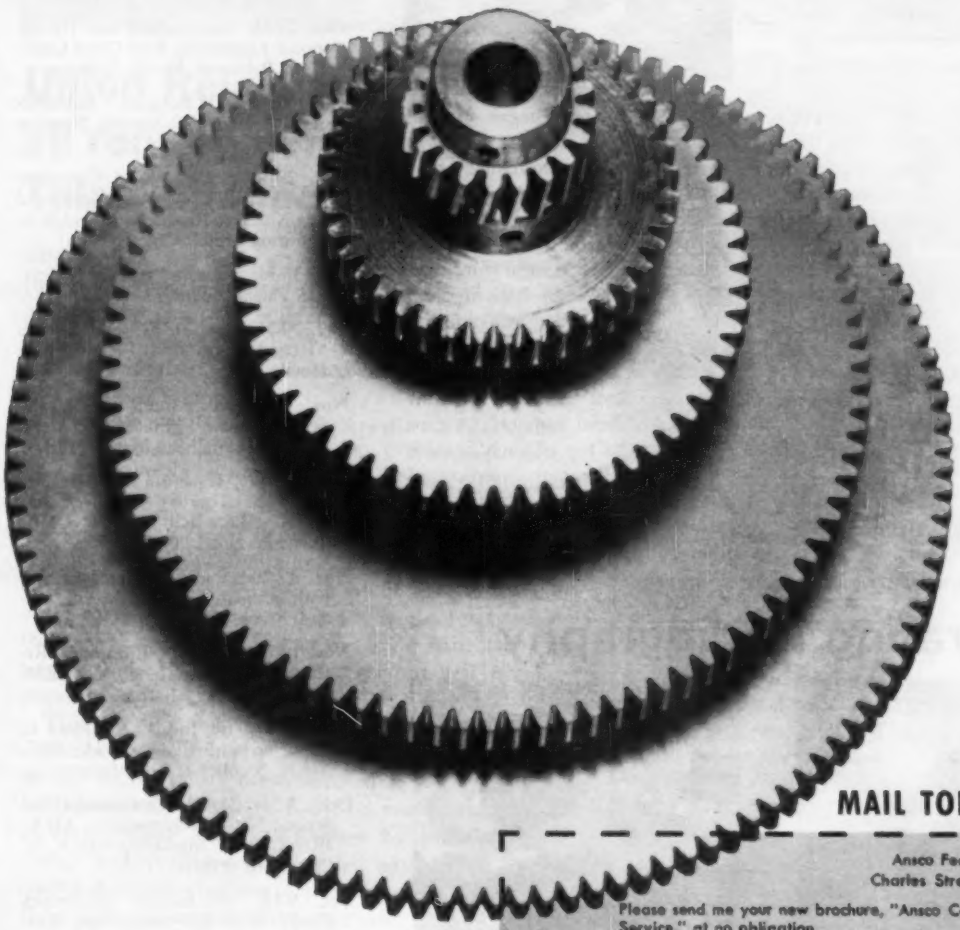
Ansco won an Army-Navy E for efficiency in the production of radar instruments, sextants, precision gear trains and computer units during the last war.

Why not consult Ansco on your next project? Ansco can certainly be of help whether you want original designs and models or you have your own specifications.

YOU may get the complete Ansco picture by writing for Ansco's illustrated brochure: *Ansco Contract Manufacturing Service.*

Ansco's

Precision assemblies are mass produced at competitive prices



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Charles Street, Binghamton, N. Y.

Please send me your new brochure, "Ansco Contract Manufacturing Service," at no obligation.

Name_____

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City_____ Zone_____ State_____

Ansco

Binghamton, N. Y. A Div. of General Aniline & Film Corp.

Despite unfavorable economic conditions last spring, none of the 1958 graduates surveyed failed to find employment, according to the Engineers Joint Council. The survey, recently released by EJC's Engineering Manpower Commission, covered more than 45 percent of the estimated 33,000 engineers graduating in 1958.

A month before graduation last June, the placement situation for 14,541 prospective graduates was: 59 percent with jobs, 9.8 percent entering graduate studies, 8.8 percent entering military service, 11.6 percent considering jobs and 10.8 percent uncommitted.

Graduates with electrical engineering degrees outnumbered graduates in other engineering fields and also got the highest percentage of job commitments before graduation.

Of 4,193 EE's, 63.8 percent were hired before graduation, 9.6 percent were entering graduate studies, 6.8 percent entering military service, 12.3 percent considering job offers and 7.5 percent were uncommitted.

By comparison, only 41.6 percent of physical science majors, 33.7 percent of business administration students and 14.9 percent of liberal arts majors were hired a month before graduation.

Survey returns received after June 20 showed that 83.5 percent of engineering graduates were hired, eight percent were entering graduate studies, 7.5 percent were entering military service and one percent were considering job offers. None of the graduates were reported to be without job offers or other firm plans upon graduation.

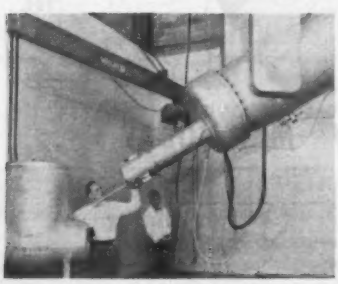
Television Saves Money for Bank

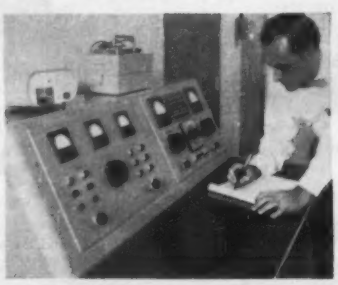
CLOSED-CIRCUIT tv began working recently for a savings bank in Waterbury, Conn., to reduce paperwork and duplicate records, and to speed up customer service.

The installation allows the bank to maintain its central files two floors above the main banking floor and still have them available for teller reference.

Four special pickup consoles on the third floor contain vertically mounted vidicon cameras. A card holder on the top of each console permits simultaneous insertion of three sets of cards containing signature specimens, bank balances or other information.

Accelerating Radiography





Crane-mounted two-million-electron-volt accelerator is positioned to x-ray massive casting at American Chain & Cable Co. Rays penetrate 10 inches of steel in 15 minutes. A slower-acting radioisotope source is used on smaller castings. Van de Graaff machine, built by High Voltage Engineering Co., has new sealed tube design which does not require auxiliary vacuum equipment. Barium-getter ion pump built into tube picks up outgassed molecules. At right, operator logs readings on control console. Accelerator is housed in chamber with four-foot concrete walls

MEETINGS AHEAD

Oct. 13-15: National Electronics Conf., 14th Annual, Hotel Sherman, Chicago.

Oct. 14-15: Institute of Printed Circuits, Fall Meeting, Chicago.

Oct. 20-21: Aero Communications Symposium, Fourth National, PGCS, Hotel Utica, Utica, N. Y.

Oct. 20-21: USA National Committee, URSI Fall Meeting, Penn State Univ., University Park, Pa.

Oct. 20-24: Society of Motion Picture and Television Engineers, 84th Convention, Sheraton-Cadillac Hotel, Detroit.

Oct. 26-31: American Institute of Electrical Engineers, Fall Meeting, Penn-Sheraton Hotel, Pittsburgh, Pa.

Oct. 27-28: Aeronautical and Navigational Electronics, East Coast Conf., Lord Baltimore Hotel, Baltimore.

Oct. 27-28: Electronic Industries Assoc., Radio Fall Meeing, Sheraton Hotel, Rochester, N. Y.

Oct. 29-30: Fifth Annual Computer Applications Symposium, sponsored by Armour Research Foundation, Morrison Hotel, Chicago.

Oct. 30-31: Aircraft Electrical Society, Pan Pacific Auditorium, Los Angeles.

Oct. 30-31; Nov. 1: Electron Devices Meeting, PGED, IRE, Shoreham Hotel, Wash., D. C.

Nov. 6-7: Prof. Group on Nuclear Science, IRE, Fifth Annual Meeting, Villa Hotel, San Mateo, Calif.

Nov. 17-20: Magnetism and Magnetic Materials, Fourth Annual Conf., AIEE, APS, IRE, AIME, OHR, Sheraton Hotel, Philadelphia.

Nov. 17-20: Radar Conference, Seventh Annual, Univ. of Miami, Miami Beach, Fla.

Nov. 19-20: Northeast Electronics Research and Eng. Mtg., NEREM, Mechanics Bldg., Boston.

Nov. 19-21: Electrical Techniques in Medicine and Biology, ISA, IRE, AIEE, Nicollet Hotel, Minneapolis.

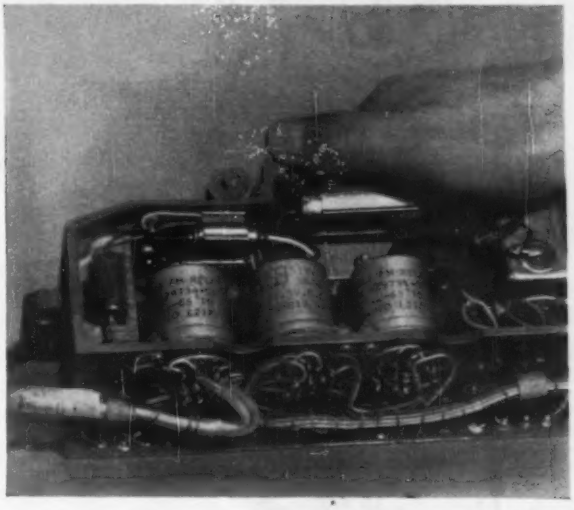
Dec. 3-5: Global Communications, Second National Symposium, AIEE, IRE, Colonial Inn-Desert Ranch, St. Petersburg, Fla.

Dec. 9-11: Mid-America Electronics Conf., Municipal Auditorium, Kansas City, Mo.

Jan. 29-30: Long-Distance Transmission by Waveguides, IRE, London, England.

Feb. 12-13: Solid-State Circuit Conf., IRE, AIEE, U. of Penn., Philadelphia.

Union Relays meet all requirements of Talos guidance system



The Talos, the Navy's long-range guided missile, is very important to the nation's defense. And Bendix Aviation Corporation, builder of the Talos, depends on a relay manufactured by Union Switch & Signal. The relay meets all the requirements of the missile's guidance control system.

That relay is the UNION miniature 6PDT (also used in the Navy's Vanguard missile). The chief reason for choosing the Union 6PDT is its extreme reliability. The probability of flight failure of a contact pair is only once in 600,000 operations. Part of the relay reliability can be attributed to its clean, simple, *rotary* design which gives it fewer inherent problems than other relays. In vibration tests, it is absolutely solid to 2,000 C.P.S. at 15 G. And in temperature tests, it has performed satisfactorily for six minutes at temperatures up to 177° C.

This 6PDT is one of a complete line of *dependable* miniature relays made by Union Switch & Signal. These ac and dc relays are manufactured to MIL-R-25018, MIL-R-6106C, and MIL-R-5757C requirements. All of these relays are distinguished by the advanced design and quality control which have made Union Switch & Signal a leading manufacturer of relays. Send the coupon for complete information.

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Union Switch & Signal, Advertising Dept.
Pittsburgh 18, Pennsylvania

Please send information on the following:

- ☐ 6PDT miniature dc and ac relays.
- ☐ New 4PDT relay which meets every requirement of MIL-R-25018.
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DIVISION OF WESTINGHOUSE AIR BRAKE COMPANY

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That man just ahead of you hopes you'll take his job away from him. He's plain selfish about it . . . that way you push him up the ladder, too.

The fellow right behind you, what about him? He's another good friend. Just help make him more capable of capturing your present spot . . . see, now he's pushing you!

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Scientific Instruments Division, Port Washington, New York

Other inquiries: AVO Limited, Avocet House, 92-96 Vauxhall Bridge Road, London, S.W.1, England

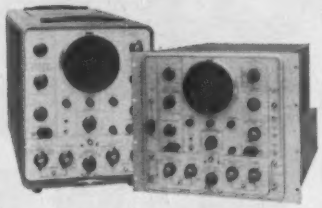
At last! A PRECISION DUAL

New 122A uses alternate sweep or 40 KC chopper for dual trace display

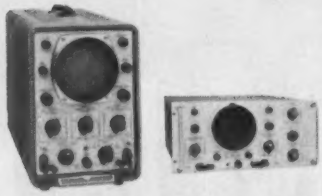
7"

New hp 122A/AR rugged cabinet or 7" high rack mount

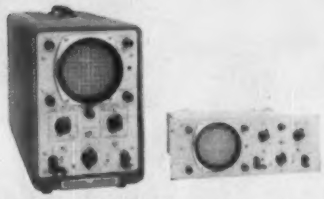
Other high performance, direct reading,



-hp- 150A/AR, DC to 10 MC. 24 sweep times, 0.02 sec/cm to 15 sec/cm. Plug-ins for high gain or dual channel use. Rack mount, $1,200; cabinet model, $1,100.



-hp- 130B/BR, DC to 300 KC. Similar X, Y amplifiers, 21 sweep times, 1 μsec/cm to 12.5 sec/cm. Balanced input 5 most sensitive ranges. Includes times-5 magnifier. $650.



-hp- 120A/AR, DC to 200 KC. 15 sweep times, 1 μsec/cm to 0.5 sec/cm. Times-5 magnifier, automatic trigger. Simple to use, rugged, outstanding value. $435.

200 KC SCOPE WITH TRACE PRESENTATION!

Big-scope versatility at moderate cost!

Here at last is a 200 KC oscilloscope — priced at just $625 — giving you "big-scope" versatility and the time-saving convenience of simultaneous two-phenomena presentation.

Engineered to speed industrial, mechanical, medical and geophysical measurements in the 200 KC range, the new *-hp-* 122A has two identical vertical amplifiers and a vertical function selector.

The amplifiers may be operated independently, differentially on all ranges, alternately on successive sweeps, or chopped at a 40 KC rate.

Other significant features include universal optimum automatic triggering, high maximum sensitivity of 10 mv/cm, 15 calibrated sweeps with vernier, sweep accuracy of ±5% and a "times-5" expansion giving maximum speed of 1 μsec/cm on the 5 μsec/cm range. Trace normally runs free, syncing automatically on 0.5 cm vertical deflection, but a knob adjustment eliminates free-run and sets trigger level as desired between —10 and +10 volts. Rack or cabinet mount; *rack mount model only 7" high.*

For complete details, write or call your *-hp-* representative, or write direct.

BRIEF SPECIFICATIONS

Sweep: 15 calibrated sweeps, 1-2-5 sequence, 5 μsec/cm to 0.2 sec/cm, accuracy ±5%. "Times-5" expander, all ranges. Vernier extends 0.2 sec/cm range to 0.5 sec/cm.

Trigger selector: Internal + or —, external or line. Triggers automatically on 0.5 cm internal or 2.5 v peak external. Displays base line in absence of signal. Trigger level selection —10 to +10 v available when automatic trigger defeated.

Vertical Amplifiers: Identical A and B amplifiers, 4 calibrated sensitivities of 10 mv/cm, 100 mv/cm, 1 v/cm and 10 v/cm; ±5% accuracy. Vernier 10 to 1.

Balanced (differential) input available on all input ranges. With dual trace, balanced input on 10 mv/cm range. Input impedance 1 megohm with less than 60 μμf shunt. Bandwidth DC to 200 KC or 2 cps to 200 KC when AC coupled. Internal amplitude calibrator provided.

Function Selector: A only, B only, B-A, Alternate and Chopped (at approx. 40 KC).

Horizontal Amplifier: 3 calibrated sensitivities, 0.1 v/cm, 1 v/cm, 10 v/cm. Accuracy ±5%. Vernier 10 to 1.

Bandwidth DC to 200 KC or 2 cps to 200 KC, AC coupled.

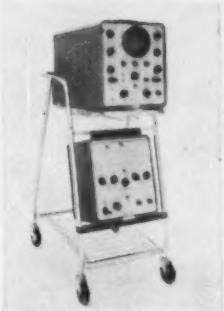
General: 5AQP1 CRT, intensity modulation terminals at rear, power input approximately 150 watts, all DC power supplies regulated.

Price: (Cabinet or rack mount) $625.00.

Data subject to change without notice. Prices f.o.b. factory.

automatic trigger (hp) oscilloscopes

***-hp-* AC-21C Voltage Divider Probe.** 50:1 divider with 10 megohm input impedance and 2.5 μμf capacitance. For *-hp-* 150A but usable with most scopes, VTVM's, preamps. $25.



***-hp-* 115A Testmobile** for 150A, other scopes. Tilts scope to 30° in 7½° stages. Heavy chrome tube construction, 4" rubber tired wheels, rolls easily, folds compactly for storage. $80.

***-hp-* 116A Storage Unit** ($22.50) hangs on 115A, holds three 150A plug-ins or ***-hp-* 117A Accessory Drawers**, $10 each.

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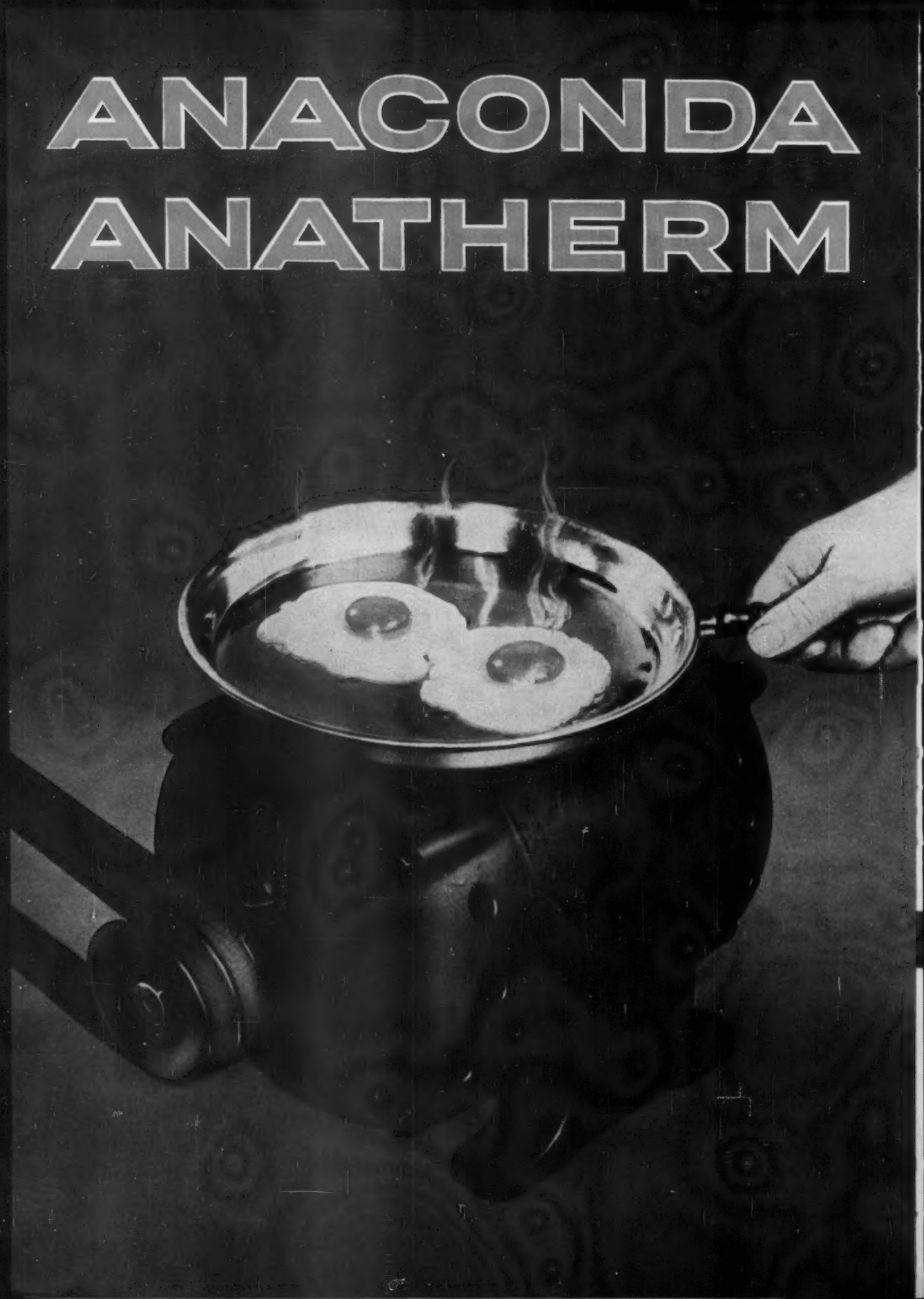

First polyester high-temperature magnet wire in full range of sizes

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— — SQUARE

— — RECTANGULAR

Anatherm, Anaconda's Class 155°C polyester film-coated magnet wire is now available in single, heavy, triple and quadruple grades of round wires (sizes 8 through 46) *and* in a full range of sizes of squares and rectangulars. This is the first time a complete range of sizes and shapes has been offered in this type wire.

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As a polyester magnet wire, Anatherm can be used equally successfully at any "hottest-spot" temperatures over the range of 105°C to 155°C. If you're on the spot about high-temperature magnet wire, ask the Man from Anaconda about Anatherm.

Write for free Anatherm technical bulletin: Anaconda Wire & Cable Co., 25 Broadway, New York 4, New York.

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solderable magnet wire

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PLAIN ENAMEL (Class A—105 C)
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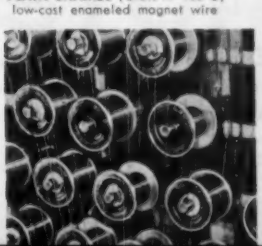

NYFORM (Class A—105 C)
high resistance to winding hazards

EPOXY (Class B—130 C)
all-round compatibility

YOUR FUTURE IS GREAT IN A GROWING AMERICA

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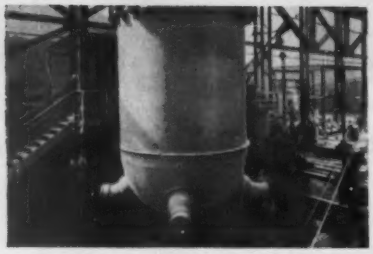
Electronics is one of our fastest growing industries. By 1965 there will be thousands of new needs and new jobs.



NUCLEAR ENERGY

Nuclear energy is now supplying power for ships and electric plants. Future possibilities are virtually unlimited.

HEALTH

Ever-increasing opportunities in research, development and production. In the field of antibiotics 50% more workers will be required.

CHEMICALS

Today there are more than 800,000 workers in chemicals and related industries. By 1970, there will be *twice* as many!

COMMUNICATIONS

As our nation grows, the demands made upon communications grow proportionately. Thousands more needs, more jobs.

EDUCATION

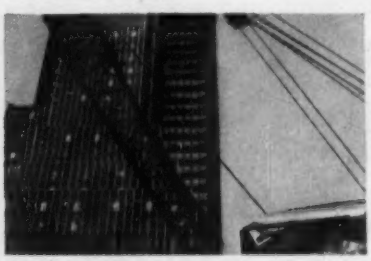
The giant school-building program now beginning will offer new jobs to many thousands of construction workers.

TRANSPORTATION

Our growing population demands constantly increasing mobility. Result: thousands of new opportunities, new jobs in the coming Jet Age.

FOODS

The trend is to labor-saving, ready-to-eat packaged foods. This new phase of an old industry will need thousands more workers.



CONSTRUCTION

3 million workers will benefit from new highway and construction programs—and even more workers will be needed soon.

7 BIG REASONS FOR CONFIDENCE IN AMERICA'S FUTURE

1. MORE PEOPLE—Four million babies yearly. U. S. population has *doubled* in last 50 years! And our prosperity curve has always followed our population curve.

2. MORE JOBS—Though employment in some areas has fallen off, there are *15 million* more jobs than in 1939—and there will be *22 million more* in 1975 than today.

3. MORE INCOME—Family income after taxes is at an all-time high of $5300—is expected to pass $7000 by 1975.

4. MORE PRODUCTION—U. S. production *doubles* every 20 years. We will require millions more people to make, sell and distribute our products.

5. MORE SAVINGS—Individual savings are at highest level ever—*$340 billion*—a record amount that is now available for spending.

6. MORE RESEARCH—*$10 billion* spent each year will pay off in more jobs, better living, whole new industries.

7. MORE NEEDS—In the next few years we will need more than *$500 billion* worth of schools, highways, homes, durable equipment. Meeting these needs will create new opportunities for everyone.

* * *

Add them up and you have the makings of another big upswing. Wise planners, builders and buyers will act *now* to get ready for it.

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Marketing includes sales, consumer research, product and package design, advertising and public relations. All need new skills every year—and *many thousands* of new workers!

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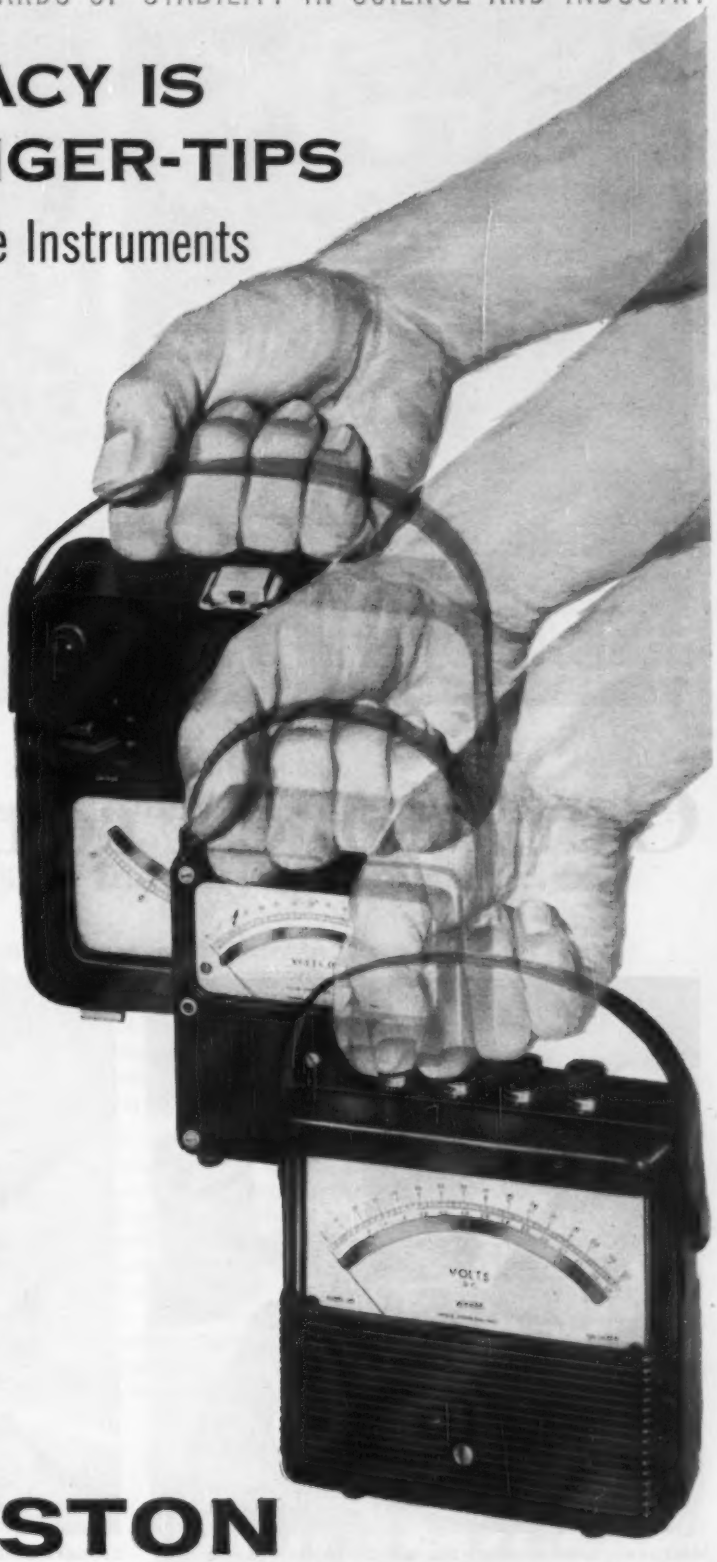
. . . with Weston Portable Instruments



Easy portability, exceptional readability, sustained high accuracy . . . these features have been painstakingly engineered into every Weston Portable. Each is hand calibrated by direct comparison with precise reference standards. All are shielded against the effects of external magnetic fields . . . far in excess of ASA requirements. Weston Portables are equipped with long mirror scales and knife-edge pointers to eliminate parallax errors. All are well compensated for temperature changes.

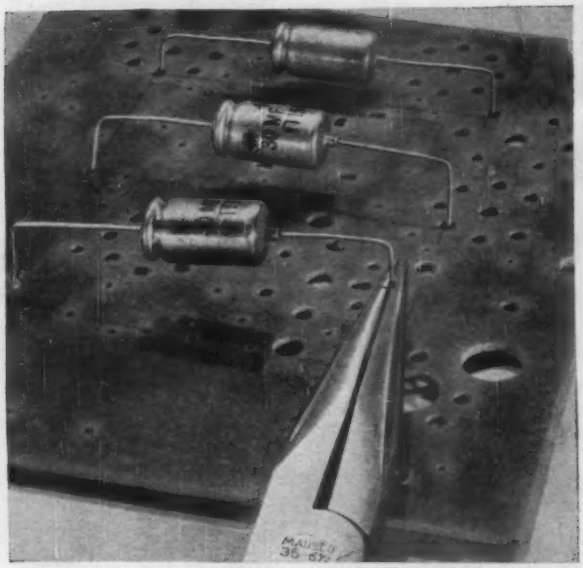
Models 931, 901 and 622 make up a graduated series of Weston Portables. They cover a broad range of applications – from general testing in field, plant or laboratory to the exacting demands of electronics, telephony and temperature measurement. The 931 group and the 901 group have scale lengths of 4.0″ and 5.5″ respectively. The unusually sensitive '622' instruments have 6.1″ scales, with proportionately greater accuracies and readability.

You'll find complete information in the Weston bulletins covering these instruments. Call your local Weston representative . . . or write to Weston Instruments, Division of Daystrom, Inc., Newark 12, N. J. *In Canada: Daystrom Ltd., 840 Caledonia Rd., Toronto 10, Ont. Export: Daystrom Int'l., 100 Empire St., Newark 12, N.J.*

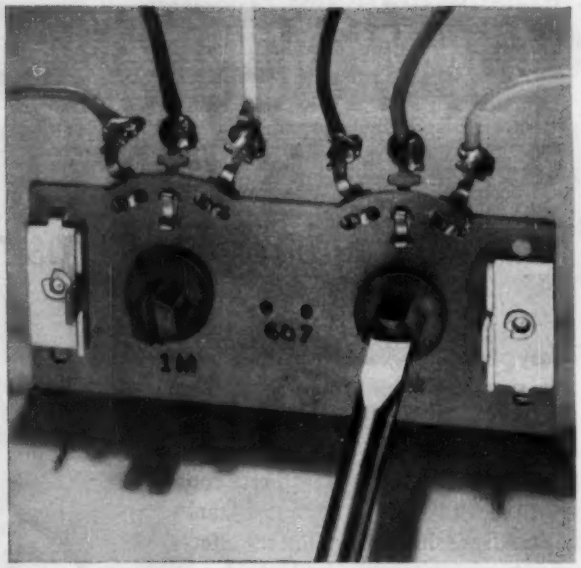
WESTON

Instruments

A DAYSTROM UNIT



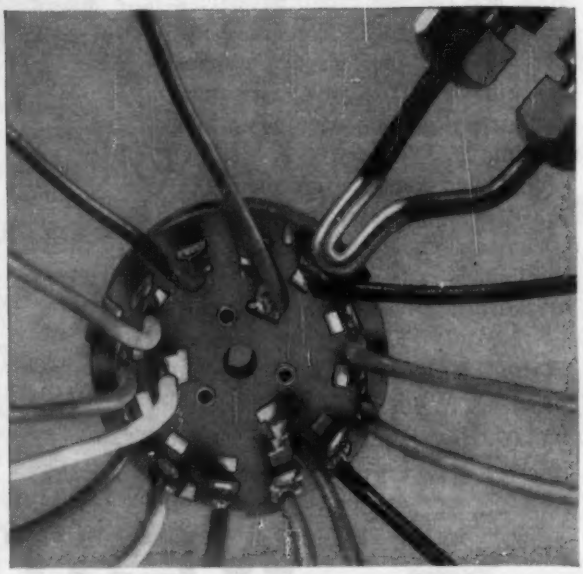
Leader in electrolytic capacitors, Mallory introduced the first dry electrolytics . . . the first 85° C capacitor, the Mallory FP . . . and the first high-temperature tantalum capacitor. In recent years, Mallory has led in progress in miniature capacitors, including those shown here...the first miniature electrolytics economically priced for commercial use; plus a complete line of subminiature tantalum models.



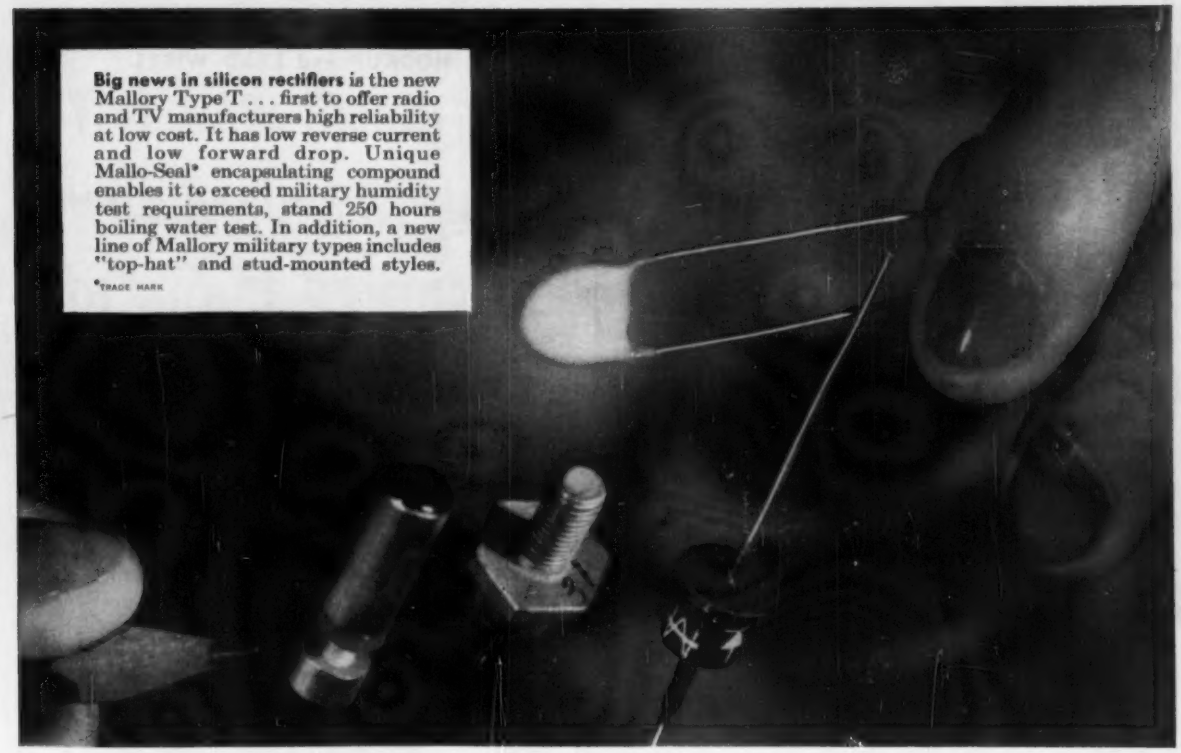
Economical strip-type controls cut manufacturing costs . . . are just one of many special Mallory designs of carbon volume controls including models for use with printed circuits, with low hop-off resistance for transistor circuits, with convenient push-pull switch. Mallory precision made wire-wound resistors include a full line of controls and vitreous enamel, cement-coated and axial lead fixed resistors.

Get More From Mallory...

Ideal power for transistors is the mercury battery, pioneered by Mallory. High energy in small volume, long life and constant discharge characteristics make this battery valuable in miniaturized, self-powered equipment. Another Mallory development is the Solidion® solid state battery, capable of storage for over 15 years. It is ideal for stockpiled systems.



Special electronic components include a wide selection of wafer and push-button switches, and a series of jacks and plugs including types for communications and military uses. The famous Mallory Inductuner, a high precision variable inductance tuning element, gives superior front-end performance in VHF and UHF bands.


Big news in silicon rectifiers is the new Mallory Type T . . . first to offer radio and TV manufacturers high reliability at low cost. It has low reverse current and low forward drop. Unique Mallo-Seal* encapsulating compound enables it to exceed military humidity test requirements, stand 250 hours boiling water test. In addition, a new line of Mallory military types includes "top-hat" and stud-mounted styles.
*TRADE MARK

. . . *More Precision Products . . . More Engineering Assistance*

In the Radio and Television Industry, *for example* . . .

From the r-f "front end" to the power supply, Mallory offers radio and television manufacturers a broad line of precision-made components . . . and skilled engineering assistance in their applications.

Batteries, capacitors, controls, resistors, switches, vibrators and tuning devices—all these products of Mallory represent the knowledge of more than thirty years of creating and manufacturing special components that have contributed greatly to electronic progress.

We at Mallory are privileged to have been among the pioneers of the radio and television industry, and to have had a part in its spectacular growth. Among our contributions have been some notable "firsts"—the first commercial vibrator, the first 85° C electrolytic capacitor, the first mercury battery, and the first silicon rectifier to provide highest quality and dependability at low commercial prices. Today, you can get from Mallory the most diversified line of components, made under a tradition of precision design and workmanship that is unequalled in the electronics industry.

Because the Mallory line is so varied and inclusive, you can depend on Mallory for engineering assistance that extends across the application of many related components in your specific radio or television circuit. Not merely specialists in a few components, but well experienced in many, our staff can lend valuable help to your designers in achieving peak over-all performance and economy. We'll welcome the opportunity for a consultation—just call or write Mallory today.

Serving Industry with These Products:

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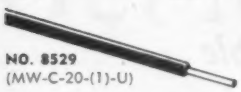
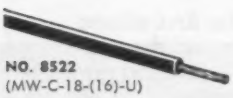
MW HOOKUP WIRE

Use for electronic devices, aircraft instruments, radio and radar transmitters, receivers, lighting and power rectifiers. Thirty color combinations. Features high dielectric strength, resistance to acids, alkalis, oil, flame and moisture. Fungus-proof. Temperature rating minus 40° C to 80° C.



NO. 8529
(MW-C-20-(1)-U)

SIZE 20 AWG
Specifications: Solid tinned copper conductor .016 vinyl insulation .066 diam. Length: 25' coil, 100' spool, 1000' spool.



NO. 8522
(MW-C-18-(16)-U)

SIZE 18 AWG
Specifications: 16 x 30 stranded tinned copper conductor .016 vinyl insulation .081 diam. Length: 25' coil, 100' spool, 1000' spool.

COAXIAL CABLES

Maximum operating efficiency in applications requiring high, very high and ultra-high frequencies.

RG-58/U RG-59A/U RG-17A/U

Army Navy Type No.	Inner Conductor In.	Diameter of Dielectr. In.	Nominal Impedance Ohms	Attenuation DB/100 Ft. 10% 400 MC	3000 MC	Nominal Overall Diameter In.
RG-58/U	0.051" 16 AWG	0.185"	50	6.5	24	0.332"
RG-17A/U	0.195"	0.680"	50	2.5	11	0.870"
RG-59A/U	0.023"	0.146"	75	9	30	0.242"

3466

HOOKUP and LEAD WIRES

Use for high voltage leads to cathode ray tubes. Features high dielectric strength, corona resistance and minimum surface leakage.

NO. 8869

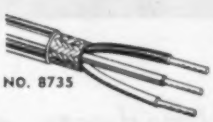
20 AWG 7 x 28 stranded copper tinned .108" nom. dia. **Specifications:** .035 flame retardant polyethylene insulation, color white. Puncture voltage 32,000 volts. Temp. rating 100° C. Suggested working voltage 10,000. Length: 25' coil, 100' spool.

NO. 8868

20 AWG 7 x 28 stranded copper tinned .168" nom. dia. **Specifications:** .065 flame retardant polyethylene insulation, color white with red strip. Puncture voltage 54,000 volts. Temp. rating 100° C. Suggested working voltage 20,000. Length: 25' coil, 100' spool.

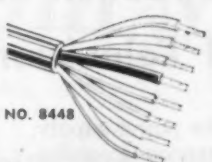
INTERCOMMUNICATING and SOUND SYSTEM CABLES

Shielded and unshielded cables available, also composite types. Designed for long service life, excellent mechanical and electrical characteristics. Use for balanced intercom systems, annunciators, telephones, control circuit cable, electronic computer cable and multiple speaker and signal systems.



NO. 8735

3 conductors 22 AWG 7 x 30 Cu. tinned .015" ins. .189" nom. dia. **Specifications:** 3 cond. vinyl plastic insulation cabled black, red and white tinned copper braid shield, vinyl jacket. Length: 15' coil, 50' coil, 100' spool, 500' spool, 1000' spool.



NO. 8448

8 conductors 22 AWG 7 x 30 strand .015" ins. .235" nom. dia. **Specifications:** Cabled, .020" vinyl jacket over all. Colors: Black, blue, brown, green, orange, red, white and yellow. Length: 100' spool, 500' spool.

NO. 8739

2 conductors 22 AWG solid .015" ins. .015" nom. dia. **Specifications:** 2 Cond. vinyl plastic insulation cabled black and red, tinned copper spiral shield, vinyl jacket. Length: 100' spool, 500' spool, 1000' spool.

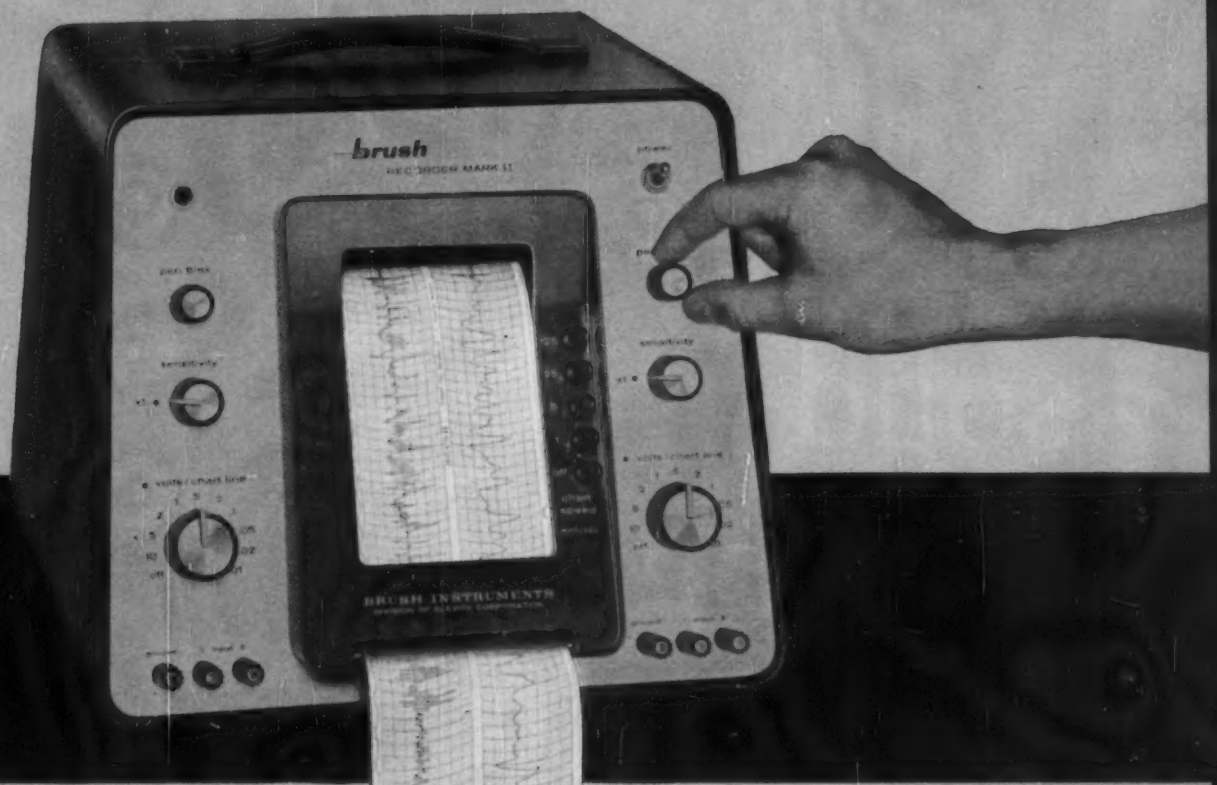
Write for complete information on the complete line of Hickory Brand Electronic Wires and Cables

HICKORY BRAND
Electronic Wires and Cables

Manufactured by
SUPERIOR CABLE CORPORATION, Hickory, North Carolina

CIRCLE 24 READERS SERVICE CARD CIRCLE 25 READERS SERVICE CARD →

The New Brush Mark II opens up whole new world of direct writing applications



Sensitivity
10mv/line (mm). Full scale deflection from chart center ± 200 mv.

Measurement Range
.010v. to 400v.

Input Impedance
5 megohm single-ended, 10 megohm balanced.

Frequency Response
D.C. to 100 cps.

Recording Channels
Four, 2 event channels and 2 analog.

Chart Speeds
1, 5, 25, 125 mm/sec.

Power Requirements
105-125v., 60 cps, 135 watts at 115v.

The portability and remarkable simplicity of the Brush Mark II make it practical to use *anywhere*.

Wherever you work—in research, design and development, production, field testing—you get an immediate *ultralinear* record of performance . . . for quick analysis and corrective action on the spot . . . for study at a later date . . . for reproduction by conventional low-cost copy methods.

As foolproof as you'd hoped for, this recorder has built-in amplifiers, permanent calibration, instant paper loading and a "white glove" writing system. Use it as a recording voltmeter . . . as a supplement to your "scopes".

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Division of
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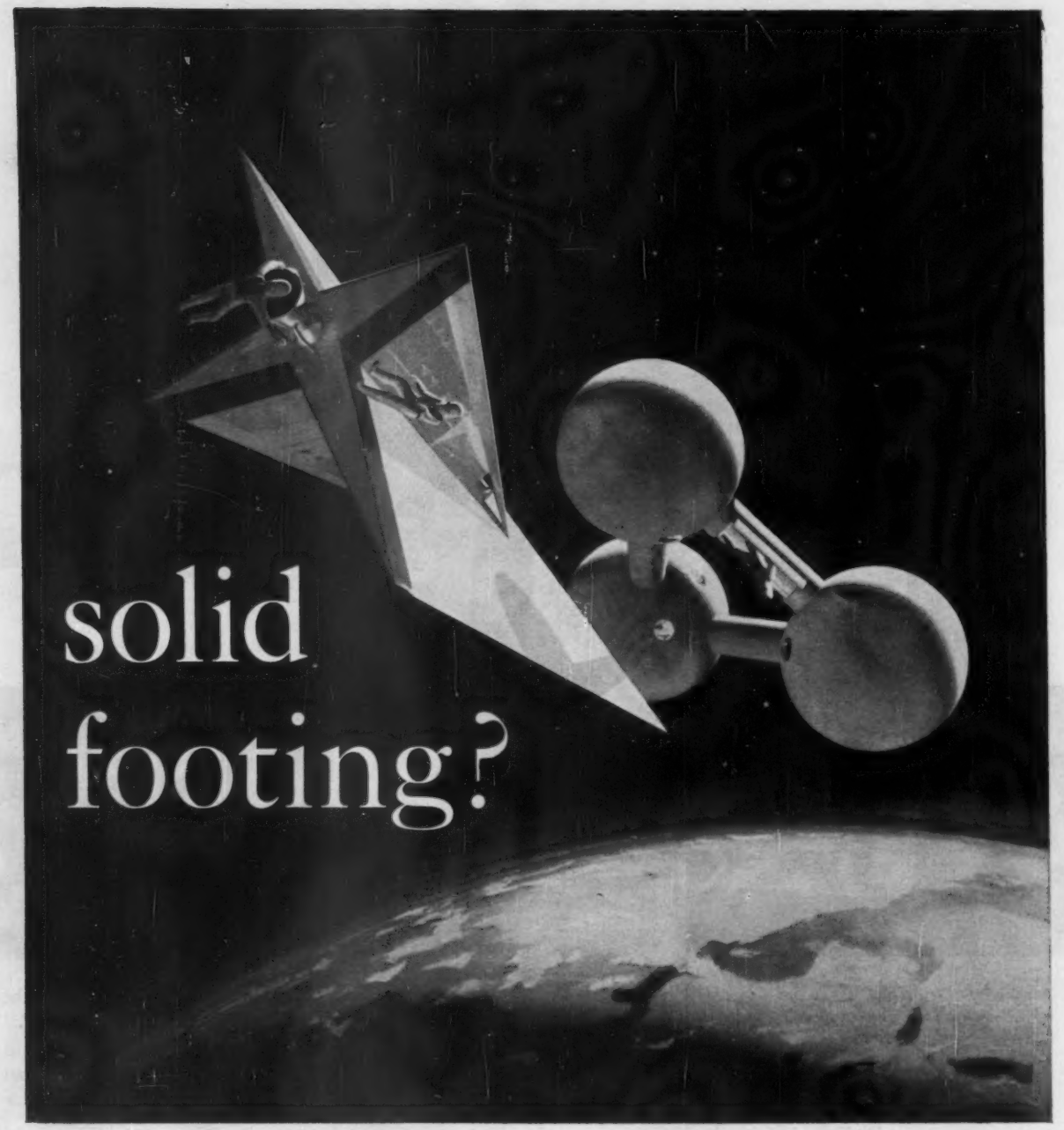

To a man floating weightless around Space Station C, these are perhaps meaningless words—but *solid footing* is highly important to most of us who live and work on the surface of the earth.

Autonetics has established a solid footing in inertial guidance through 12 years of successful development and production of airborne and ocean-going systems, as well as systems for space applications.

The healthy growth of the Autonetics Guidance Engineering department—based on a number of highly diversified contracts—has created new senior-level positions in the fields of electro-mechanical component development and system analysis.

Well qualified, experienced men will find solid footing in this permanent, progressive, and successful organization—plus the chance to create and to grow in one of today's most challenging fields.

But time's a-wasting. *Now* is the time to find out what the future holds for *you* at Autonetics.

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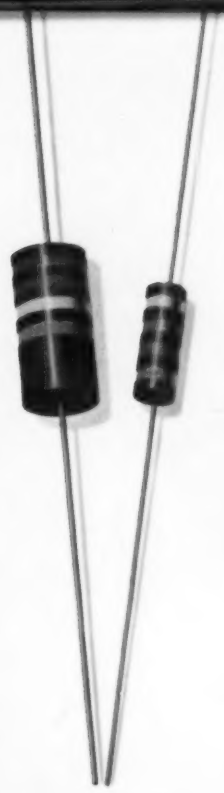
NERVE CENTER OF THE NEW INDUSTRIAL ERA **Autonetics**
A DIVISION OF NORTH AMERICAN AVIATION, INC.

CIRCLE 27 READERS SERVICE CARD→



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New smaller size—1 watt

Ask your IRC salesman about NEW GBT Carbon Composition Resistors

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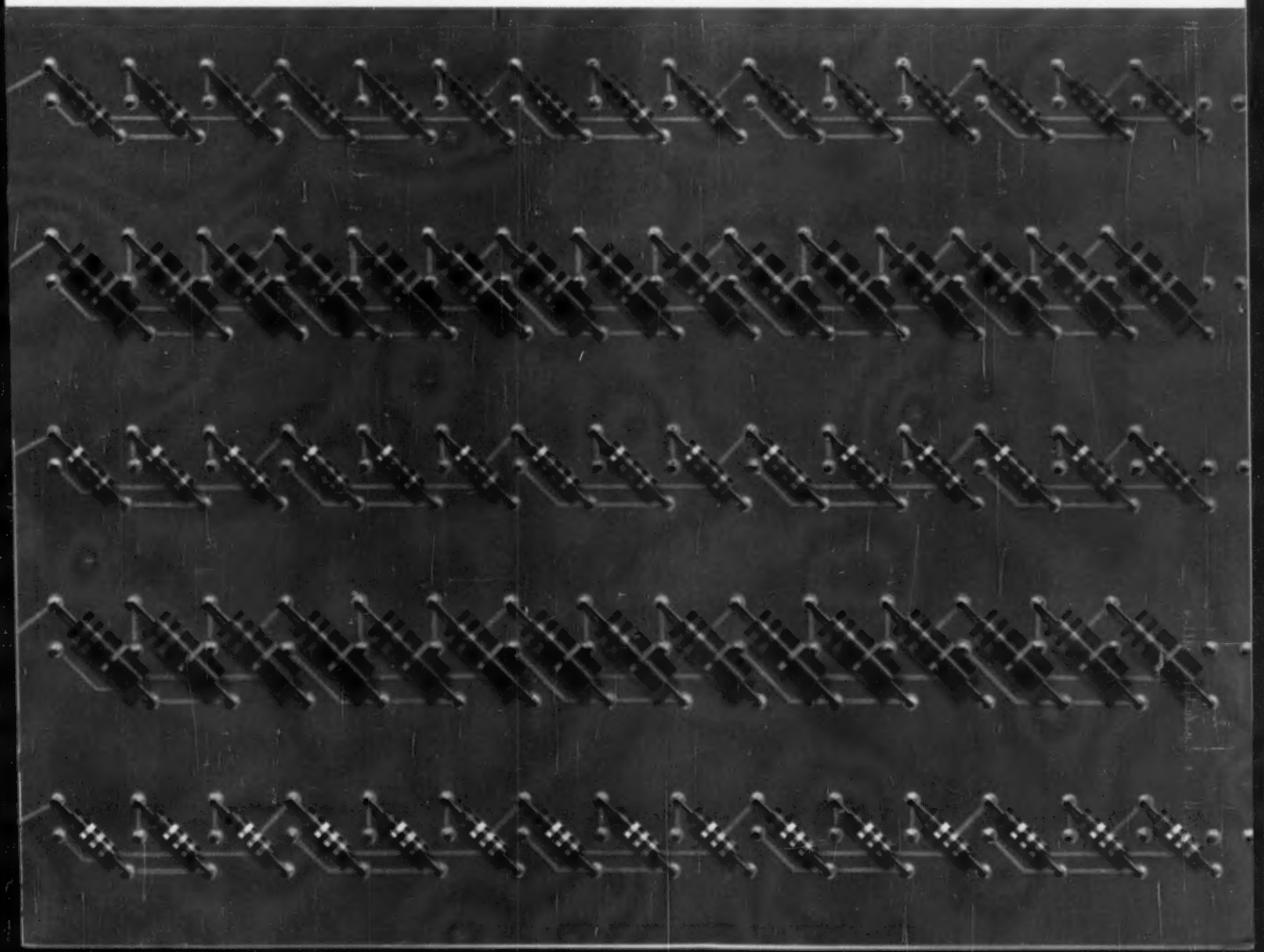

Temco

AIRCRAFT
DALLAS

Making major breakthroughs in brazing stainless sandwich

Two radically new process developments by Temco Engineering may well revolutionize the entire concept of fabricating stainless steel honeycomb structures. One is "Temcombing," Temco's *continuous process* of stainless sandwich fabrication. The other is a simplified "Two-Phase" method for brazing stainless honeycomb structures. Patents now are being applied for on both of these processes.

Conventional, time-consuming batch brazing methods seem primitive compared with Temcombing. Panels of virtually unlimited size now are feasible in place of small, batch-made panels, thus reducing weight and critical tolerance errors. After lay-up, finished Temcomb panels can be turned out at rates up to 18 inches per minute, and at considerably *lower costs than by batch methods.*

Temco's exclusive Two-Phase resistance brazing method eliminates the need for furnace operations. For complex shapes, the Two-Phase process is the fastest and most advanced developed to date.

Advanced weapons systems, probing beyond Mach 3, demand whole new domains of materials and reliability. Temco engineering capabilities are meeting these demands with new developments and fabrication techniques in stainless steel, titanium, and other high-temperature materials. Pioneering in design, tooling and production for tomorrow's spacecraft industry is part of Temco's complete systems capabilities — all ready to meet *your* challenge.

TEMCO
AIRCRAFT CORPORATION • DALLAS, TEXAS

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Only Merck makes all three forms of ultra-pure

SILICON

for semiconductor applications

Merck Polycrystalline Billets—have not been previously melted in quartz, so that no contamination from this source is possible. Merck guarantees that single crystals drawn from these billets will yield minimum resistivities over 50 ohm cm. for n type material, and over 100 ohm cm. for p type material. Merck Silicon Billets give clean melts with no dross.

Merck Polycrystalline Rods—are ready for zone melting as received . . . are ideal for users with floating-zone melting equipment. Merck Polycrystalline Rods (8½ to 10½ inches long and 18 to 20 mm. diameter—smaller diameters on special order) yield more usable material. In float-zone refining one can obtain minimum resistivities of 1000 ohm cm. p type with minimum lifetime of 200 microseconds.

Merck Single Crystal Silicon—offers manufacturers without floating-zone equipment semiconductor Silicon of a quality unobtainable elsewhere. No crucible-drawn crystals can match the reliability of Merck single crystal material in semiconductor devices. Merck Single Crystal Silicon is available with min. resistivity of 1000 ohm cm. p type. Other resistivities ranging from 1.0 ohm cm. p or n type up to 1000 ohm cm. will soon be available.

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For additional information on specific applications and processes, write Merck & Co., Inc., Electronic Chemicals Division, Dept. ES-8, Rahway, N.J.

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Here's the advanced Printmaster 810—with features that outdate every other whiteprinter in its price class. Now you can assure yourself of better whiteprints, more easily, in less time.

1. **More compact—lower in height** . . . saves valuable floor space, allows easier lamp replacement, better control . . . means less fatigue.
2. **New design of brush feed assembly** . . . to automatically control curled edges, folded corners.
3. **New print pick-off** . . . prevents tearing, sticking or scratching.
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And Ozalid offers other great *proven* features such as new steel frame support . . . double paper rods . . . both rear and front delivery . . . and U/L approved safety devices.

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CIRCLE 30 READERS SERVICE CARD

CIRCLE 31 READERS SERVICE CARD→

1K20 Series X and K Band Klystron (left)
1K125C Series C Band Klystron (right)

Eimac Announces...

Six New Ceramic Reflex Klystrons

Two important frequency ranges in the C, X and K bands are now covered by Eimac ceramic reflex klystrons. Eimac's advanced stacked ceramic design gives these tubes exceptional ruggedness and frequency stability.

The four new tubes of the 1K20 series cover 8500 to 11,700 Mc. at power levels to 50 milliwatts. These tubes are specifically designed for use in the severe vibration and temperature environment of air-borne and missile radar systems. They will withstand vibration levels of 15G in any reference plane with less than 100 kilocycle frequency deviation. Rated for use at any altitude, the 1K20 series tubes are conservatively rated at +250°C seal temperature. A new non-contacting, non-microphonic tuner permits noise-free tuning of the tubes through their complete ranges. Low beam voltage requirement and simple radiation cooling minimize the weight and complexity of associated equipment.

Two new C-band tubes comprising the 1K125 series cover 3700 to 5000 Mc. Power levels up to 2 watts make these tubes ideal for reliable broadband point-to-point communication. Tuning by dielectric slug rather than variable RF gap avoids sensitivity to shock and vibration. Integral-finned cooler and higher operating temperature ratings minimize cooling requirements.

Eimac know-how in the field of ceramic-metal tube design now brings compactness, ruggedness, high performance and reliability to these important microwave frequencies.

For further information request a copy of the brochure "A New Line of Eimac Reflex Klystrons"

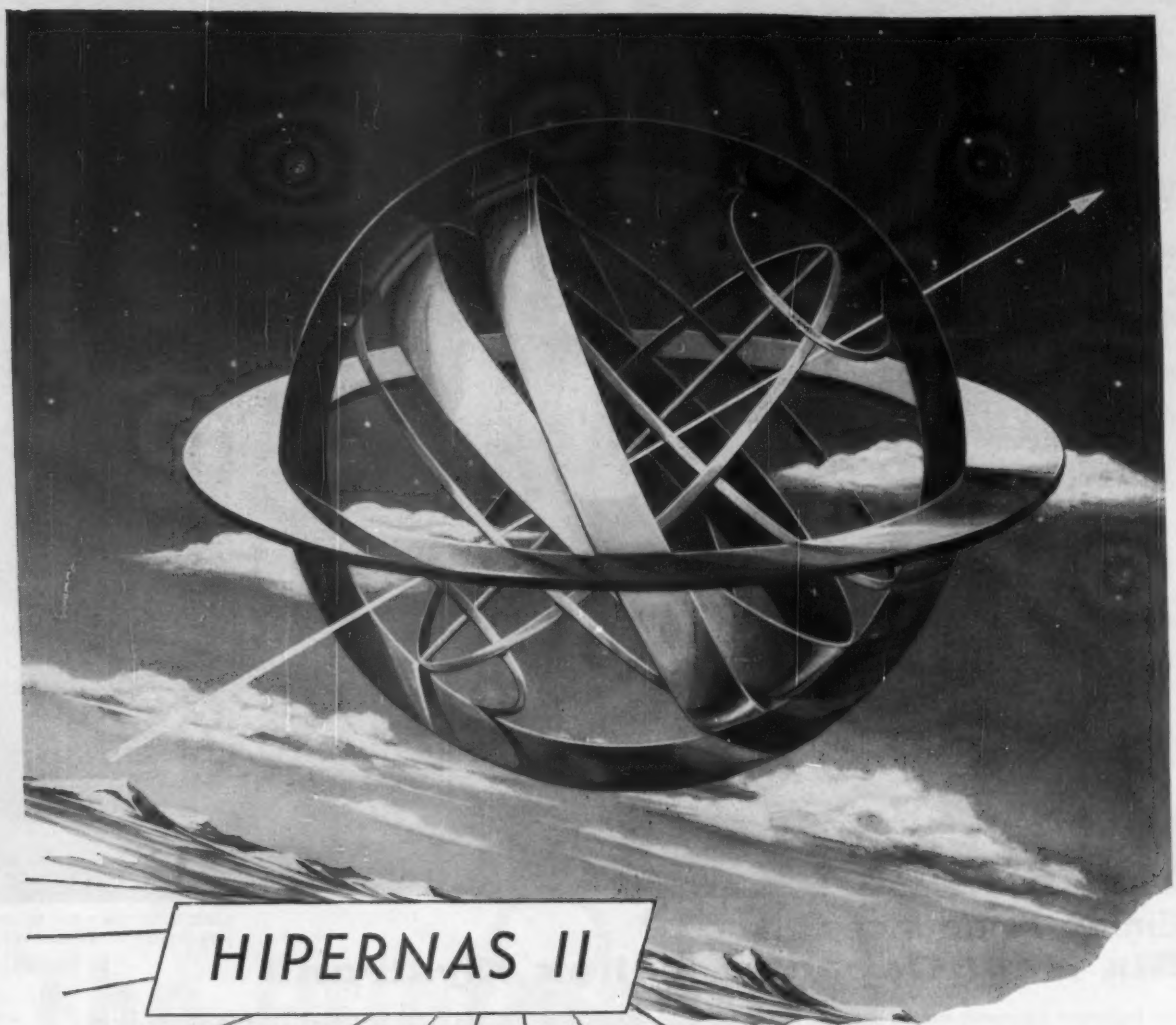
EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA
Cable Address: EIMAC, SAN CARLOS

Eimac First for ceramic reflex klystrons

Eimac®

GENERAL CHARACTERISTICS

Type	Freq. Range Mc.	Beam Voltage	Power Output Range	Reflector Voltage
1K125CA	3700-4400	1000 Vdc	1.5 to 2.0 W	0 to —500 Vdc
1K125CB	4400-5000	1000 Vdc	2.0 to 2.3 W	0 to —500 Vdc
1K20XS	8500-9300	300 Vdc	25 to 50 mW	0 to —250 Vdc
1K20XK	9200-10,000	300 Vdc	25 to 50 mW	0 to —250 Vdc
1K20XD	10,000-10,800	300 Vdc	25 to 50 mW	0 to —250 Vdc
1K20KA	10,700-11,700	300 Vdc	25 to 50 mW	0 to —250 Vdc



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Assignments embrace a high level of design and development problems. Learn about the personal opportunities and unexcelled benefits now available to you on this challenging program. Send resume of your qualifications to: Supervisor of Engineering Employment, Dept. H-51, BELL AIRCRAFT CORPORATION, P. O. Box One, Buffalo 5, New York.

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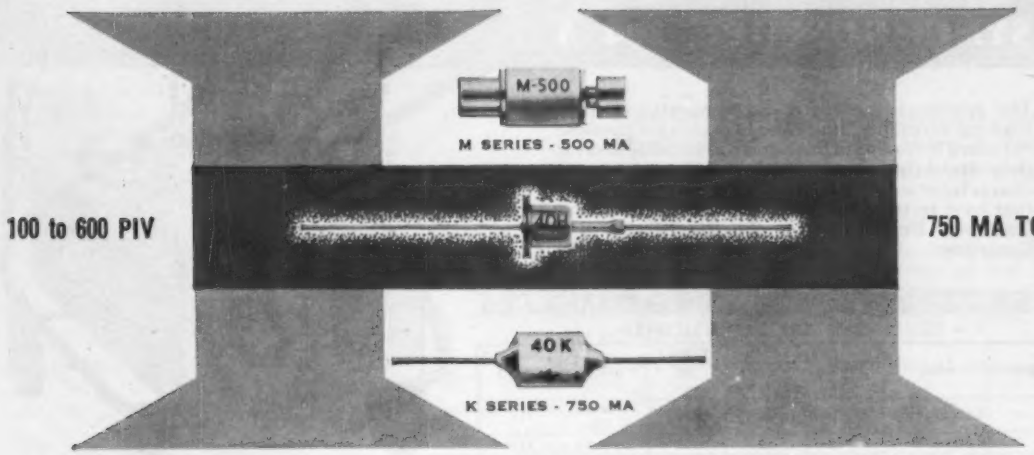
Announcing A NEW MEMBER OF THE Tarzian SILICON RECTIFIER LOW CURRENT FAMILY...

The H Series



RECTIFIERS ACTUAL SIZE

ELECTRICAL RATINGS
CAPACATIVE LOAD

S. T. Type	Max. Peak Inverse Volts	Max. RMS Volts	CURRENT RATINGS—AMPERES											
			Max. D. C. Load			Max. RMS			Max. Recurrent Peak			Surge 4MS Max.		
			55°C	100°C	150°C	55°C	100°C	150°C	55°C	100°C	150°C	55°C	100°C	150°C
10H	100	70	.75	.5	.25	1.875	1.25	.625	7.5	5.	2.5	30	30	15
20H	200	140	.75	.5	.25	1.875	1.25	.625	7.5	5.	2.5	30	30	15
30H	300	210	.75	.5	.25	1.875	1.25	.625	7.5	5.	2.5	30	30	15
40H	400	280	.75	.5	.25	1.875	1.25	.625	7.5	5.	2.5	30	30	15
50H	500	350	.75	.5	.25	1.875	1.25	.625	7.5	5.	2.5	03	30	15
60H	600	420	.75	.5	.25	1.875	1.25	.625	7.5	5.	2.5	30	30	15

Features

- High Reliability— Extra Heavy Duty Junction
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- Small Size
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NUCLEAR ENERGY
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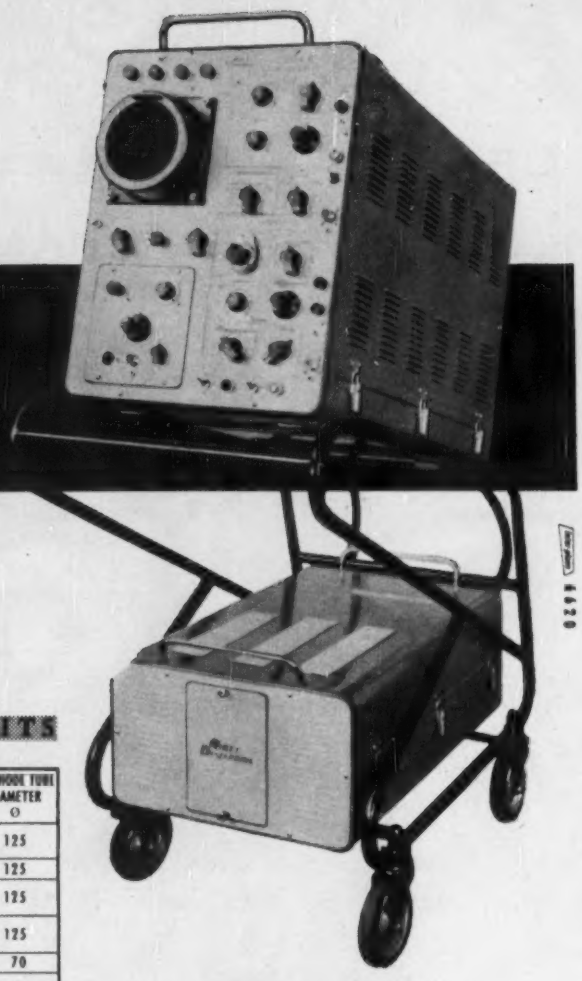

RIBET DESJARDINS

SYNCHROSCOPE 204 A

The synchroscope 204 A, an apparatus of very high performance, is unique in making it possible to record ultra-rapid phenomena reaching several thousand kilometers-second. It offers the same characteristics of precision and safe operation that have secured the universal reputation of the Electronic Department of the Ribet-Desjardins Company.

MEASURE AND CONTROL UNITS

I - OSCILLOSCOPES AND SYNCHROSCOPES

MODELS	CHANNELS	RANGE	AMPLI V Passing Band cps - mc	AMPLI V Sensitivity mV/p to p/cm	RESPONSE LAG µs	MARKER	CATHODE TUBE DIAMETER Θ
204 A	1	0.01µs/cm-4s/cm	0 - 50	50	0.007	Calibrated + 100 µs	125
251 A	2	0.02µs/cm - 10 s/cm	0 - 30	50	0.02	Calibrated	125
252 BL	1	0.1µs/cm-4 ms/cm	0 - 10 10 - 10	80 50	0.04	0.05µs-1000µs	125
254 A	2 1	0.1µs/cm-1 s/cm 0.1µs/cm-1 s/cm	0 - 4 0 - 10	20 50	0.12 0.045	Calibrated	125
255 A	1	0.3µs/cm-0.01 s/cm	0 - 4	150	0.12	0.4µs-4 ms	70
256 A	1 2	1µs/cm-1 s/cm 1µs/cm-1 s/cm	0 - 1 0 - 0.8	15 50	—	Calibrated	90
258 A	1	2µs/cm-20 ms/cm	50 - 1	50	—	—	70
264 B	2	1µs/cm-0.05 s/cm	10 - 2	6	—	—	90
267 B	1	1µs/cm-0.1 s/cm	0 - 1 20 - 0.8	250 8	—	—	90
268 A	1	10 cps - 30 kc	50 - 1	45	—	—	70

II - GENERATORS AND WOBBLERS

MODELS	FREQUENCY RANGE	SIGNAL	PRECISION	MODULATION	VOLTAGE	PRECISION
406 B	20 cps - 200 kc		+/— 1,5 %	—	20 or 2x10 V	3 %
409 A	10 - 300 mcs		>0.1 % min. quartz marker	FM	0.1 V	—
410 A	0 - 250 mcs		>0.1 % min. quartz marker	FM	0.1 V	—
411 A	0 - 320 mcs		>0.1 % min. quartz marker	FM	0.2 V and 0.1 V	—
428 A	100 kcs - 30 mc		>1 % min.	AM	0.1 V constant level	—
476 A	100 kcs - 26 mc		>1 % min. and >2 % min.	FM	0.1 V	—
457 B	5 cps - 50 kc K = A/a : 2-20		2 %	—	10Vz int. 100Vz ext.	+/— 5%
458 A	5 cps - 50 kc (repeat) 0.5µs - 10.000µs		5 %	—	2 x 50 V z int.	+/— 5%

III - SUPPLY - MEGOHMMETERS - SUNDRY UNITS

MODELS	DESCRIPTION AND GENERAL FEATURES
111 C	100' - 400' : 200 mA 100' - 15 mA. Heating 1'.3 - 25 V up to 6 amps.
114 A	100' - 250' : 150 mA 150' - 10 mA. Heating 6.3 V, 3 amps.
674 B	5 Mohm - 100 kMohm in 4 measuring ranges at 280 V. cont. controlled
803 B	Pressure and Vibration Detector for fluids and solids
804 B	Static and Dynamic Extensometric Units
805 A	Magnetic detection of faults in composition and treatment in large components
806 A	Magnetic detection of faults in composition and treatment in small parts
713 A	Cathodic Oscilloscope with 5 or 6 curves for all industrial investigations

Ribet-Desjardins are, among others, suppliers for :

The French Atomic Energy Authority, National French Center for Scientific Research, the Marcel Dassault Aircraft Works, the Bretigny Flight Test Center, the French National Defence, SNCF (the French Railways), Oerlikon (Switzerland), Transmission Services for the Belgian and Netherlands Armies, the Universities of Liege and Brussels, Polish and Yugoslav Central Purchasing Authorities, Brandt Company, French Public Health (neuro-biologic services for hospitals).

In order to receive technical particulars on the equipment of interest to you please write to

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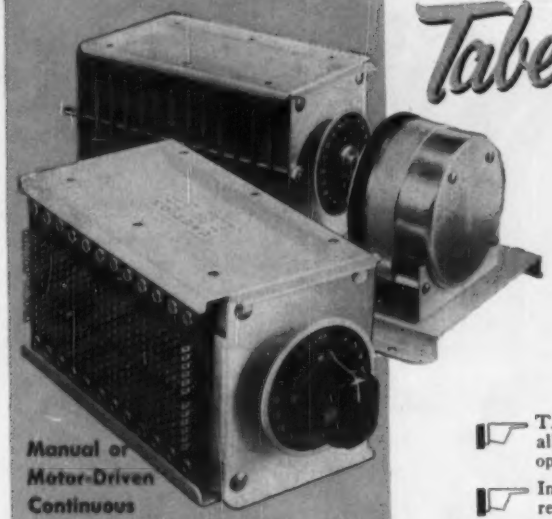
NEW Idea Obsoletes Old Switches

For Telemetering . . Missiles . . Computers . . Communications

Tabet ROTARY WAFER PRINTED ETCHED SWITCH

- **Saves time and money on operating and repairs.**
- **Has definitely longer life.**
- **Now being supplied, under U. S. Gov't specifications, for use by the Navy in communications equipment both aboard ship and in shore installations.**

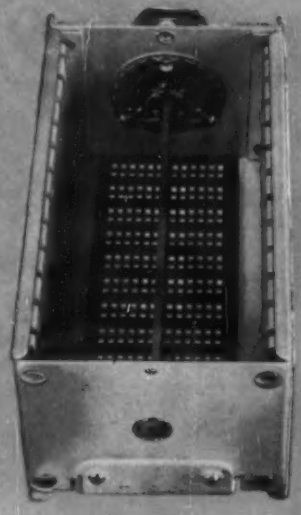


Manual or Motor-Driven Continuous or Stepping

- TABET Rotary, Wafer Switches have been proved by extensive tests on all types of time sequence switching for both manual and motor driven operation. Easily adaptable for stepping switch service.
- Individual TABET switch wafers (including rotary sections) are instantly removable without unsoldering or disassembling.
- TABET printed circuit wafers permit unlimited choice of switch circuit configurations.
- TABET wafers plug into rugged, semi-floating, printed circuit receptacles —which can be designed to match any wafer-circuit terminating patterns.
- TABET wafer contact surfaces are heavily silver-plated for maximum life and low-resistance contact. Rhodium plating is used for motor-driven, high speed switching.

An outstanding feature of the TABET Rotary Switch is the *ease* with which repairs and alterations can be made.

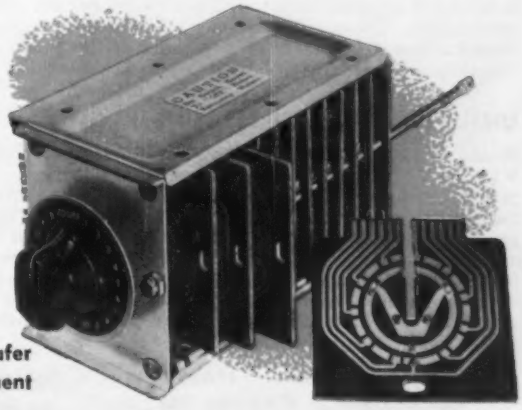
- It never is necessary to remove wires from the TABET Switch.
- Both the TABET wafers and their receptacles are easily removed.
- It is impossible to make errors in replacements on the TABET Switch.



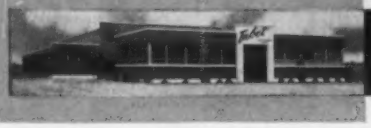
Wafer Housing Assembly

TABET Rotary, Wafer Switches can be supplied with one to twenty-four wafers.

TABET Rotary, Wafer Switches are manufactured under U. S. Patent Nos. 2,832,901 and 2,841,660. Other U. S. and Foreign patents presently are pending.



Switch Showing Wafer Mounting Arrangement



For full information on the adaptability of TABET Switches to needs of your business, address:

Tabet MANUFACTURING CO., INC.

1336 BALLENTINE BOULEVARD NORFOLK, VIRGINIA

New Sizes ! OHMITE®

EXPANDED LINE! EXCLUSIVE FEATURES!

OHMITE, universally recognized manufacturer of high quality electrical components, now offers industry an expanded line of variable transformers. The three basic models listed below provide current ratings sufficient to meet a large percentage of industrial applications. The new line is available in enclosures, tandem assemblies, and other modifications. Ohmite, the only manufacturer in the industry producing both power rheostats and variable transformers, offers rheostat-transformer tandem combinations.

UNSURPASSED OHMITE CONSTRUCTION!

Note all these advanced Ohmite "v.t." features: *greater capacity for equal size*—Models VT2 and VT4 offer a "bonus" in current at no increase in cost over comparable competitive units; *positive current transfer*, achieved in all "v.t." models—a pigtail from the brush to a large slip-ring contacts a large area of the terminal; *table or panel mounting*—on Models VT4 and VT8, shaft can be positioned for panel or table use; *interchangeable with other popular types of variable transformers*—Model VT2 has single-hole mounting, Models VT4 and VT8 match popular 3- or 4-hole mountings; *reversible direct reading dial*—calibrated on one side for normal line connection and on the other side for overvoltage connection; heavily plated rhodium brush track guarantees *longer, trouble-free performance.*

BASIC MODELS

MODEL VT2
Input voltage: 120v, 60 cycle.
Output voltage: 0-132, 0-120.
Max output at any brush setting: 1.5 amp.

MODEL VT4
Input voltage: 120v, 60 cycle.
Output voltage: 0-140, 0-120.
Max output at any brush setting: 3.5 amp.

MODEL VT8
Input voltage: 120v, 50/60 cycle.
Output voltage: 0-140, 0-120.
Max output at any brush setting: 7.5 amp.

AVAILABLE FROM OHMITE DISTRIBUTORS OR DIRECT FROM FACTORY

RHEOSTAT—TRANSFORMER TANDEM ASSEMBLIES

MANY VARIATIONS

Transformers can be provided with many variations to meet different requirements such as special shafts, mountings for varying panel thicknesses, auxiliary switches, taps on transformer winding for fixed intermediate voltages, and motor drives for remote control or servo-operation.

"Vt." Variable Transformers

INDUSTRY'S MOST ADVANCED DESIGN!

ENCLOSURES

Ohmite Variable Transformers are available in enclosures for portable or fixed use (back-of-panel or surface mounting). Units feature modern styling, rugged construction, and are designed for convenience.

TANDEM ASSEMBLIES

Ohmite Tandem Assemblies can be furnished in all three sizes of Ohmite Variable Transformers. Exclusive! Ohmite can also provide tandem assemblies combining famous Ohmite Power Rheostats, and Ohmite Variable Transformers.

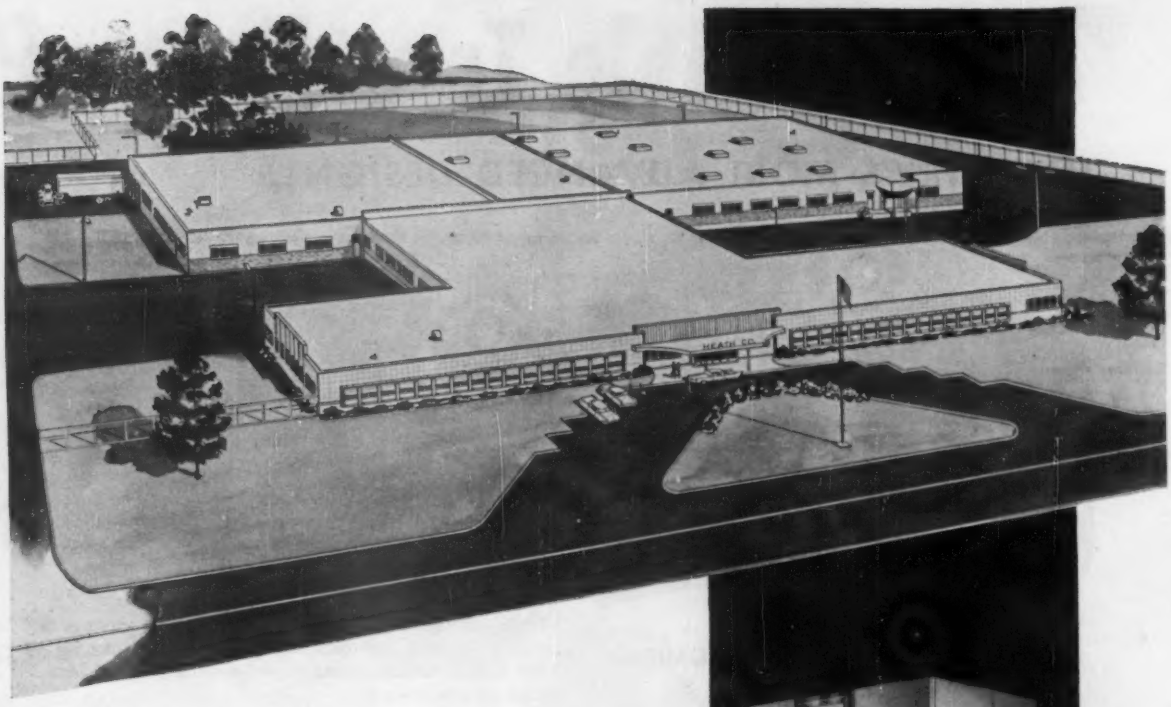
Write for Bulletin 151

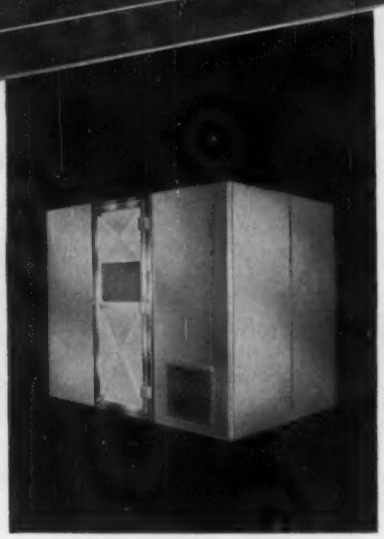
OHMITE®

RHEOSTATS RESISTORS RELAYS
TAP SWITCHES R.F. CHOKES
VARIABLE TRANSFORMERS
TANTALUM CAPACITORS

MANUFACTURING COMPANY

3610 HOWARD STREET • SKOKIE, ILLINOIS





New Heath plant equipped with ACE shielded enclosures

Heath Company — manufacturer of the famous Heathkit line of Amateur Radio Kits, Hi-Fi Equipment and Electronic Instruments—believes in positive r-f interference protection. The company's new plant at Benton Harbor, Michigan, has ACE shielded enclosures for its design and development work . . . for repairs and alignment. All critical measurements are completely shielded from r-f interference.

ACE's patented RFI* and Cell-Type Designs guarantee high attenuation with dependable r-f interference protection at all frequencies. Modular construction permits quick-and-easy size changes. Enclosures are designed and constructed to ensure permanent r-f leak-proof performance.

• • •

Let an ACE Engineer help you work out an effective and economical solution to *your* shielding problem. Whether your problem involves one unit or many, you'll find that ACE has the experience and the facilities to handle the complete job. Write for free catalog on standard ACE enclosures.

*Lindsay Structure

ACE

First and Finest in Shielded Enclosures

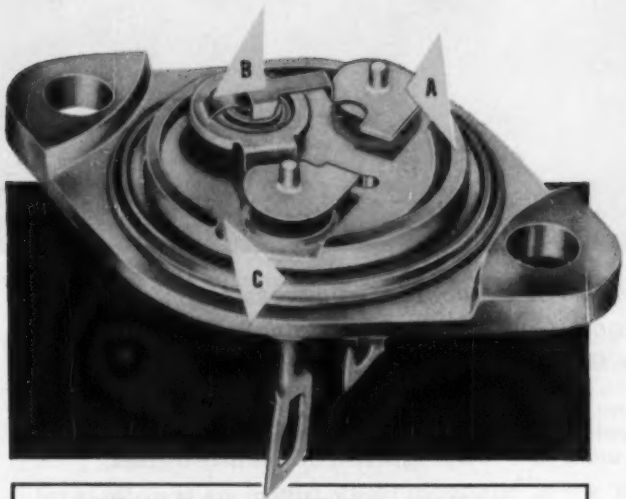
ACE ENGINEERING & MACHINE CO., INC.

Tomlinson Road • Huntingdon Valley • Pennsylvania

designed for dependability!

MOTOROLA

high power / high current Transistors



The unique internal design of these high power transistors enables Motorola to achieve volume production while maintaining a laboratory standard of quality.

A ● Motorola's unusual "clip technique" eliminates internal wiring . . . greatly improving device dependability. Self-jigging, automatic assembly prevents human error . . . enables Motorola to specify exact limits.

B ● Miracle-Ring Emitter provides greater effective area permitting higher current operation.

C ● Industry standard TO-3 package with solder terminals and welded hermetic seal is designed to meet or exceed the mechanical and environmental requirements of military specification MIL-T-19500A.

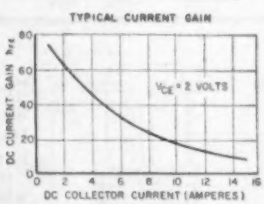
Because of Motorola's advanced design and carefully controlled production techniques, you can incorporate these Motorola transistors in your circuits with complete confidence that they will provide highest efficiency . . . maximum reliability.

. . . write for complete technical data, TODAY!

GENERAL SPECIFICATIONS

TYPE NUMBER	BV_{cbo} max volts	BV_{ces} max volts	h_{FE} I_C=10A min	h_{FE} I_C=10A max	$V_{CE\ sat}$ I_C=10A I_B=1A max volts
2N627	40	30	10	30	1.0
2N628	60	45	10	30	1.0
2N629	80	60	10	30	1.0
2N630	100	75	10	30	1.0

FOR COMPLETE TECHNICAL INFORMATION
concerning these
high power/high current transistors,
write, wire or phone
MOTOROLA, INC.
5005 East McDowell Road
Phoenix, Arizona
BRidge 5-4411
Teletype Px 80



"DEPENDABLE QUALITY IN QUANTITY"
MOTOROLA SEMICONDUCTORS

MOTOROLA, INC., 5005 E. McDOWELL, PHOENIX, ARIZONA

REGIONAL OFFICES

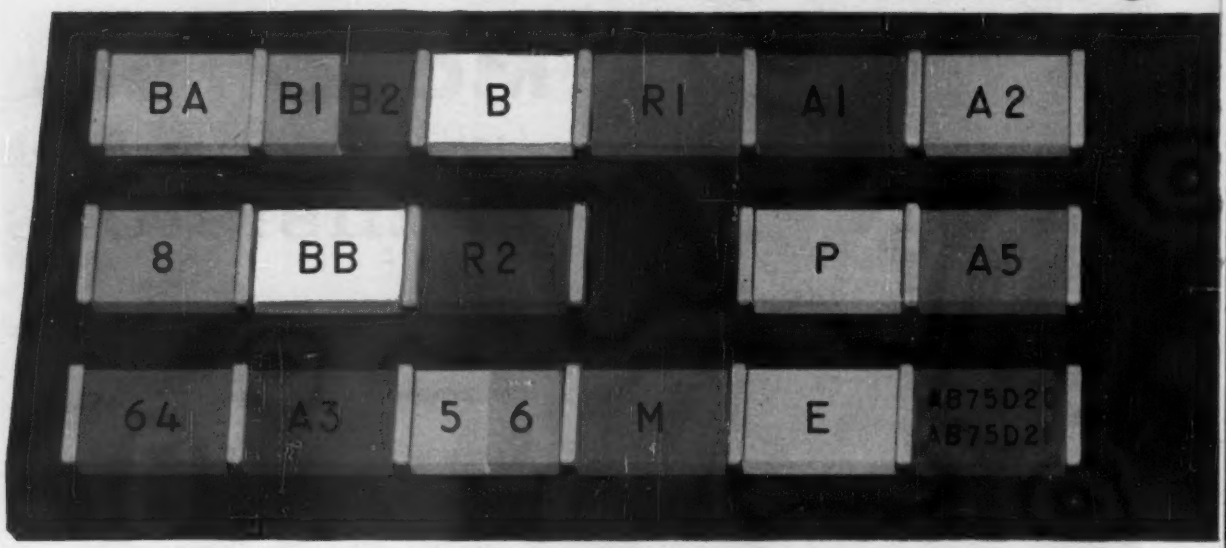
RIDGEFIELD, NEW JERSEY
540 Bergen Boulevard
WHitney 5-7500

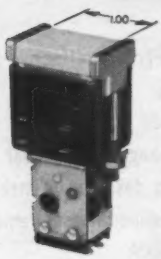
CHICAGO 44, ILLINOIS
4900 West Flourney Street
ESterbrook 9-5200

HOLLYWOOD 38, CALIFORNIA
6555 Sunset Boulevard
HOllywood 5-3250

MICRO SWITCH Precision

These Lighted Pushbutton Switches Versatility . . . Flexibility





2-Pole Unit

"100PB3" Series
Maintained contact, alternate action operation. Each push of the button alternately transfers and restores the contacts of the two switches. The switches in this and other "100-PB" series assemblies are the "SM" subminiature.

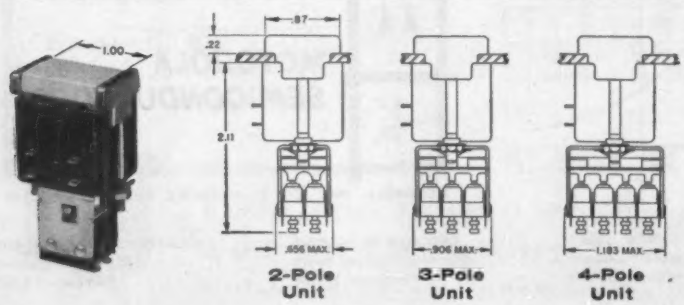
Designed For Computers, Business Machines, Electronic Data Processing Equipment, Scientific Instruments and Communication Systems

The above panel illustrates how the "100PB" series lighted pushbutton switches can be mounted in openings to accommodate one or more units, each button separated by assembly barriers.

The 1.00″ x 0.75″ translucent plastic buttons are available in red, yellow, blue, green or white—easily replaced or interchanged. Pushbutton, lamp, and switch are combined into a single assembly, thus reducing panel area to an absolute minimum. Lamp and switch terminals are isolated.

These switch assemblies and indicator lights simplify construction of panels, combine good appearance in minimum space. Each switch assembly contains two lamps for choice of lamp circuitry.

Switch assemblies, except "100PB3" series, are available with two, three, or four SPDT subminiature switches, rated at 5 amps 125

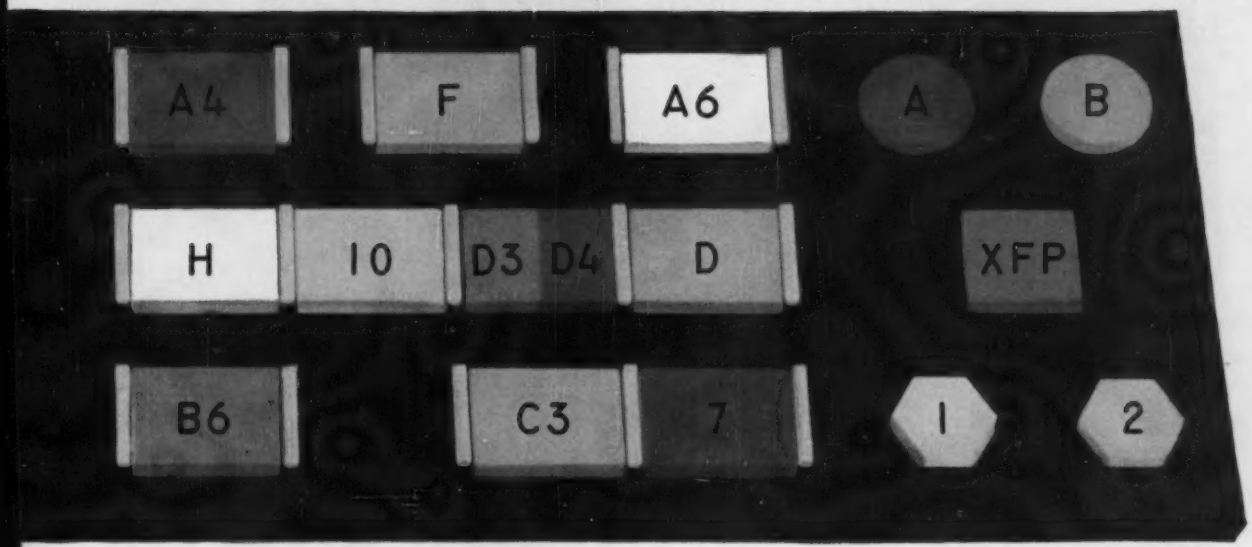


2-Pole Unit | 3-Pole Unit | 4-Pole Unit

"100PB1" Series
Momentary action—contact transfer only while button is depressed. Provides positive "touch feedback" or "feel" which reduces the chance of false operation. 2, 3, or 4-pole units are available.

Switches have uses unlimited

have--Eye Appeal . . .
. . . Require Less Panel Area



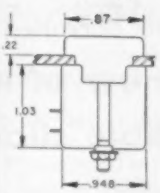
or 250 vac; or 3 amps inductive, 5 amps resistive, 30 vdc. *Send for Data Sheet 143.*

[The five buttons at the right of the main illustration are of the "50PB" series. Buttons of four shapes, in red, yellow, blue, green and white are available. *Send for Data Sheet 133.*]

MICRO SWITCH . . . FREEPORT, ILLINOIS
A division of Honeywell
In Canada: Honeywell Controls, Ltd., Toronto 17, Ontario

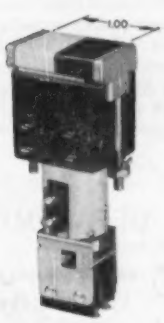
Consult with a MICRO SWITCH Sales Engineer.
Look in the Yellow Pages for location of Branch Office

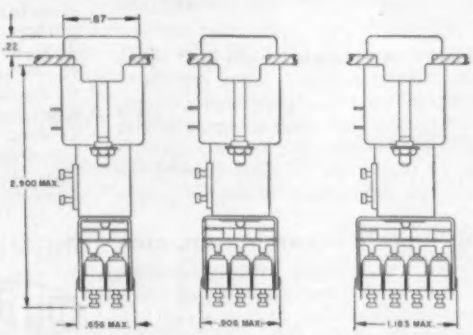
Honeywell
MICRO SWITCH PRECISION SWITCHES



"100LT1" Series
Matching indicating light assembly, without switch mechanism. Provides panel harmony. Has same button and lamp combinations, and same means of mounting as the complete switch assembly.

LT1 Indicating Light Assembly

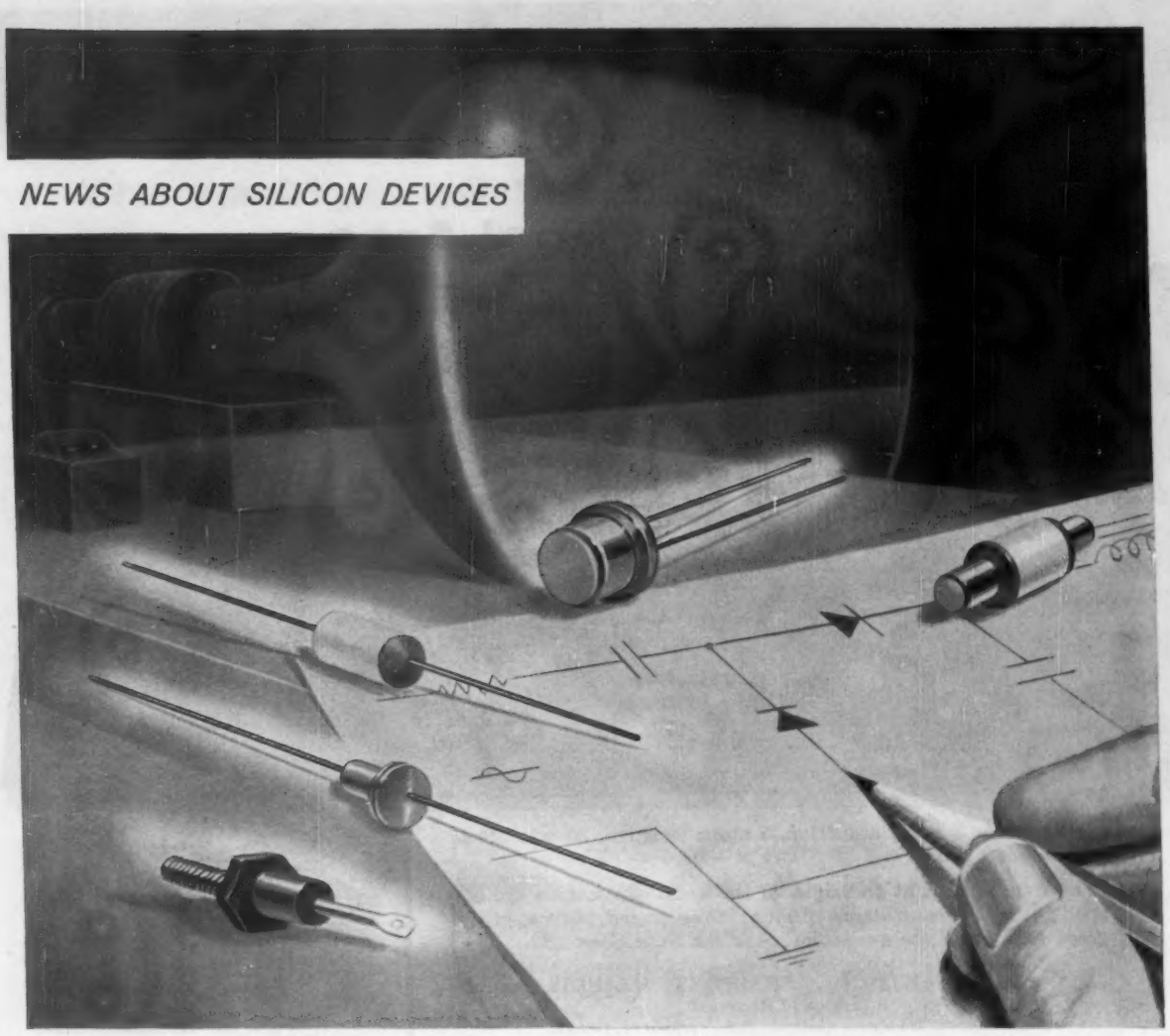




2-Pole Unit | 3-Pole Unit | 4-Pole Unit

"100PB4" Series
Magnetically held "MAGSWITCH" contains a d-c solenoid whose terminals are electrically isolated from the lamp and switch terminals. With solenoid not energized switch action is momentary; with solenoid energized switch contacts remain transferred until electrically released. 2, 3, or 4-pole units are available.

NEWS ABOUT SILICON DEVICES



Reverse current: 10^{-7} amp. Rectification ratio: 10,000,000:1

Now... new efficiency for TV power supplies with dependable diodes of Du Pont Hyperpure Silicon

More efficient power supplies . . . savings in space and weight . . . important reasons why TV manufacturers are replacing conventional rectifying systems with silicon diodes. Today, several types of silicon diodes and rectifiers are readily available for TV circuits. TV manufacturers have tested silicon rectifiers and report no noticeable change in output voltage under continuous load conditions over long periods of time. Silicon components can operate in ambients from –65° to 150° C. They maintain excellent electrical stability and resist aging.

Silicon components have high shock and vibration limits. They are up to 99% efficient in units operated at 60 cps. and require little maintenance. Silicon cells permit a rectification ratio as high as 10 million to 1—almost negligible reverse conductance. Silicon bridges are available with ratings from 1 to 1,000 amperes and more than 600 volts rms.

Note to device manufacturers: You can produce silicon transistors, rectifiers and diodes of the highest quality with Du Pont Hyperpure Silicon. It's now available in three grades for maximum efficiency and ease of use . . . with a purity range of 3 to 11 atoms of boron per billion. Technical information on crystal growing is available from Du Pont . . pioneer producer of semiconductor-grade silicon.

NEW BOOKLET ON DU PONT HYPERPURE SILICON

You'll find our new, illustrated booklet about Hyperpure Silicon helpful and interesting—it describes the manufacture, properties and uses of Du Pont Hyperpure Silicon. Just drop us a card for your copy. E. I. du Pont de Nemours & Co. (Inc.), Pigments Department, Silicon Development Group, Wilmington 98, Delaware. (This offer limited to United States and Canada.)

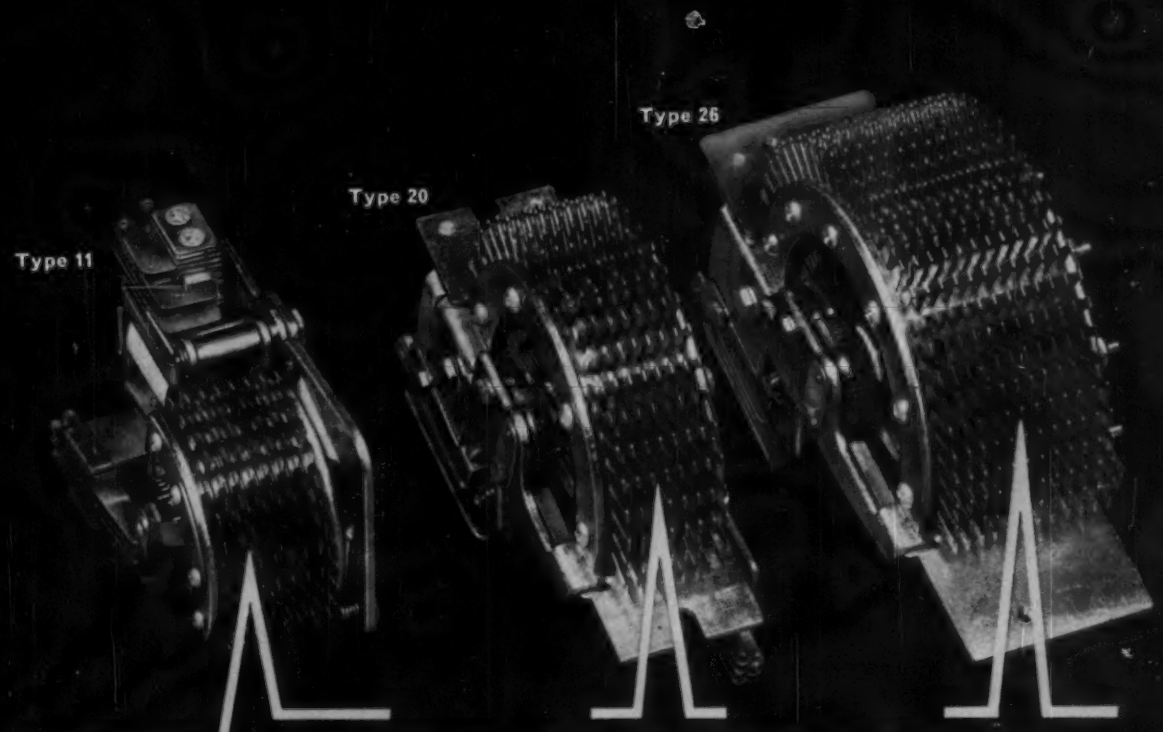
PIGMENTS DEPARTMENT

DU PONT HYPERPURE SILICON

BETTER THINGS FOR BETTER LIVING
. . . *THROUGH CHEMISTRY*

CIRCLE 42 READERS SERVICE CARD

CIRCLE 43 READERS SERVICE CARD→



NEW BLUE INSULATION

adds another refinement to CLARE Springdriven Stepping Switches

STANDARD AT NO EXTRA COST

CONSIDER

what these Superior Features will do for YOU !

• HIGH INSULATION RESISTANCE

100,000 megohms minimum between switch points and between each point and frame.

• STABLE INSULATION RESISTANCE

Maintains 100,000 megohms minimum resistance over temperature range from −55°C to +85°C.

• LOW MOISTURE ABSORPTION

Maintains low leakage characteristics in humid environment. Water absorption: 48 hours at 50°C, 0.5% (ASTM Test D570).

• GOOD ARC RESISTANCE

Endures arcing from wiper contacts, maintaining high resistance to dielectric breakdown. Arc resistance: 140 seconds (ASTM Test D495).

• MECHANICAL STRENGTH & STABILITY

High tensile and compression strengths. Holds mechanical dimensions throughout age and temperature variations (vital to retention of stack tightness.) Lifetime shrinkage: approximately .001 in./in.

• MEETS MIL SPECIFICATIONS

MIL—P—14D (Type MDG)
MIL—P—4389 (USAF)

This new Blue Insulation supplied as standard on all CLARE *Springdriven Stepping Switches as soon as present stocks of Bakelite insulators are used up. No extra cost.*

Find out the many other superior qualities of CLARE *Springdriven Stepping Switches. Call or write: C. P. Clare & Co., 3101 Pratt Blvd., Chicago 45, Illinois. In Canada: C. P. Clare Canada Ltd., 2700 Jane Street, Toronto 15. Cable Address:* CLARELAY.

Send for CLARE Engineering Bulletin #101

CLARE RELAYS

FIRST in the industrial field

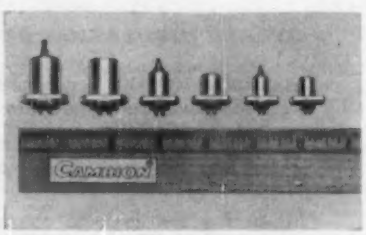
These shielded coil forms offer the utmost in reliability due to their unique design and construction. Dimensions when mounted, including terminals, are: LS-9, 7/16" diameter x 1/2" high; LS-10, 5/8" x 1 1/16"; LS-11, 1 1/16" x 1 1/32". Each form mounts by a single stud. Single layer or pie-type windings to your specifications. LS-14 is double-ended for primary and secondary windings with separate tuning slugs for independent tuning of each section; its overall length excluding tuning slugs is 1 13/64"; OD is 1/4". See photograph below for new aluminum housing shielded coil forms.

Reliability – under any condition!

Cambion® miniaturized shielded coil forms are highly shock resistant. With mechanically enclosed, completely shielded coil winding, they bring all the ruggedness and dependable performance you require for your "tight spot" applications — IF strips, RF coils, oscillator coils, etc.

Cambridge Thermionic Corporation combines *quality control* with *quantity production* to supply exactly the components you need, in any amount. Our *quality control* includes material certification, checking each step of production, and finished product. And Cambion *quantity production* means we can fill your orders for any volume, from smallest to largest.

Any Cambion coil form may be wound to your specifications in any desired quantity. For samples, specifications and prices, write to Sales Engineering Dept., Cambridge Thermionic Corporation, 437 Concord Ave., Cambridge 39, Mass. On the West Coast contact E. V. Roberts and Associates, Inc., 5068 West Washington Blvd., Los Angeles 16 and 1560 Laurel St., San Carlos, Cal.



New aluminum housing shielded coil forms with anodized finish. Available in three sizes, as variable tamper-proof units with positive locking mechanism and more precise tuning, or as fixed shielded coil forms. Flange mounted by means of two number 2-56 screws. Mounted heights above chassis are 1/4", 5/8", and 1/2" (in variable units exclusive of tuning element).

CAMBRIDGE THERMIONIC CORPORATION

CAMBION®

Makers of guaranteed electronic components, custom or standard

Volume output makes Tung-Sol/Chatham 6528 available for widespread use!

Enthusiastic acceptance of the 6528 Twin Power Triode forced rapid expansion of production quotas, in turn resulting in lower manufacturing costs. These savings are reflected in lower prices to the user making Type 6528 economically practical for a vast number of new industrial and military applications.

Type 6528 requires fewer passing tube sections . . . permits lower range control circuits . . . and combines low internal tube drop with top control sensitivity — a definite advantage over previous series regulators. Also, 6528 triodes may be used in parallel or separately. This simplifies circuitry . . . saves space.

DESIGN FEATURES OF TUNG-SOL/CHATHAM TYPE 6528!

1. Hard glass envelope permits full out-gassing . . . takes higher temperatures without gas evolution . . . increases thermal shock resistance.
2. Zirconium-coated graphite anodes assure excellent gettering. Graphite virtually unaffected by heat.
3. Oversize cathodes provide adequate emission reserve . . . eliminate standby deterioration.
4. Extra-rugged grids. Sturdy chrome-copper side rods support gold-plated molybdenum lateral wires.
5. Overall ruggedness. Metal snubbers and ceramic insulators support mount. Heavy button-stem has rigid support leads.

Tung-Sol Electric Inc. specializes in special-purpose tube development . . . can match any design requirement you have. For full data on Type 6528 . . . to fill any power tube socket . . . contact: Tung-Sol Electric Inc., Newark 4, N. J. Commercial Engineering Offices: Bloomfield and Livingston, N. J.; Culver City, Calif.; Melrose Park, Ill.

TYPE 6528 RATINGS

Max. plate dissipation per tube	60 watts
Max. plate dissipation per section	30 watts
Max. steady plate current per section	300 ma.
Max. plate voltage	400 volts
Max. heater cathode voltage	300 volts
Amplification factor*	9
Transconductance per section*	37,000 μmhos

**Average characteristics at $E_b = 100v$, $E_c = -4v$, $I_b = 185$ ma.*

TUNG-SOL®

CIRCLE 45 READERS SERVICE CARD

FREQUENCY STANDARDS

*3⅛" high
400 - 1000 cy.

PRECISION FORK UNIT
TYPE 50

Size 1" dia. x 3¾" H. Wght., 4 oz.*
Frequencies: 240 to 1000 cycles
Accuracies:—
Type 50 (±.02% at —65° to 85°C)
Type R50 (±.002% at 15° to 35°C)
Double triode and 5 pigtail parts required
Input, Tube heater voltage and B voltage
Output, approx. 5V into 200,000 ohms

FREQUENCY STANDARD
TYPE 50L

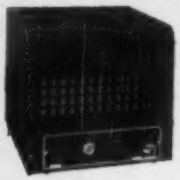
Size 3¾" x 4½" x 5½" High
Weight, 2 lbs.
Frequencies: 50, 60, 75 or 100 cycles
Accuracies:—
Type 50L (±.02% at —65° to 85°C)
Type R50L (±.002% at 15° to 35°C)
Output, 3V into 200,000 ohms
Input, 150 to 300V, B (6V at .6 amps.)

*3½" high
400 to 500 cy.
optional

PRECISION FORK UNIT
TYPE 2003

Size 1½" dia. x 4½" H. Wght. 8 oz.*
Frequencies: 200 to 4000 cycles
Accuracies:—
Type 2003 (±.02% at —65° to 85°C)
Type R2003 (±.002% at 15° to 35°C)
Type W2003 (±.005% at —65° to 85°C)
Double triode and 5 pigtail parts required
Input and output same as Type 50, above

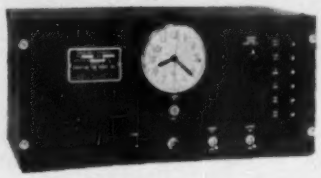
FREQUENCY STANDARD
TYPE 2005



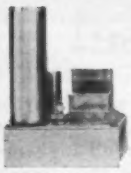
Size, 8" x 8" x 7¼" High
Weight, 14 lbs.
Frequencies: 50 to 400 cycles (Specify)
Accuracy: ±.001% from 20° to 30°C
Output, 10 Watts at 115 Volts
Input, 115V. (50 to 400 cycles)

FREQUENCY STANDARD *NEW*
TYPE 2007-6
TRANSISTORIZED, Silicon Type
Size 1½" dia. x 3½" H. Wght. 7 ozs.
Frequencies: 400 — 500 or 1000 cycles
Accuracies:
2007-6 (± .02% at —50° to +85°C)
R2007-6 (±.002% at +15° to +35°C)
W2007-6 (±.005% at —65° to +125°C)
Input: 10 to 30 Volts, D. C., at 6 ma.
Output: Multitap, 75 to 100,000 ohms

FREQUENCY STANDARD
TYPE 2121A



Size
8¾" x 19" panel
Weight, 25 lbs.
Output: 115V
60 cycles, 10 Watt
Accuracy:
±.001% from 20° to 30°C
Input, 115V (50 to 400 cycles)



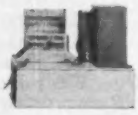
FREQUENCY STANDARD
TYPE 2001-2

Size 3¾" x 4½" x 6" H., Wght. 26 oz.
Frequencies: 200 to 3000 cycles
Accuracy: ±.001% at 20° to 30°C
Output: 5V. at 250,000 ohms
Input: Heater voltage, 6.3 - 12 - 28
B voltage, 100 to 300 V., at 5 to 10 ma.

FREQUENCY STANDARD
TYPE 2111C

Size, with cover
10" x 17" x 9" H.
Panel model
10" x 19" x 8¾" H.
Weight, 25 lbs.
Frequencies: 50 to 1000 cycles
Accuracy: (±.002% at 15° to 35°C)
Output: 115V, 75W. Input: 115V, 50 to 75 cycles.

ACCESSORY UNITS
for TYPE 2001-2



L—For low frequencies multi-vibrator type, 40-200 cy.
D—For low frequencies counter type, 40-200 cy.
H—For high freqs, up to 20 KC.
M—Power Amplifier, 2W output.
P—Power supply.

This organization makes frequency standards within a range of 30 to 30,000 cycles. They are used extensively by aviation, industry, government departments, armed forces—where maximum accuracy and durability are required.

WHEN REQUESTING INFORMATION
PLEASE SPECIFY TYPE NUMBER

American Time Products, Inc.

Watch Master
Timing Systems

Telephone: PLaza 7-1430

580 Fifth Ave., New York 36, N. Y.

THE NEW LIGHTWEIGHT A-MP "240" PATCHCORD PROGRAMMING SYSTEM

. . . means lightning fast in-flight reprogramming of airborne electrical/electronic circuitry . . . obsoletes fixed circuit connectors and other systems requiring hours or days to rewire . . . and offers these unusual features:

- removable patchboards to permit complete reprogramming in seconds
- 3¼ pounds to minimize weight . . . miniaturized to conserve space
- rugged shock and vibration-resistant construction with high strength aluminum alloy
- shock-resistant seating of patchcord plugs in removable board
- AMP's patented wiping action that pre-cleans contacts for top electrical performance
- 240 contacts for greatest versatility in circuit combinations or program arrangements

For more information on this new airborne wiring technique, AMP's Patchcord System Catalog is available on request.

AMP INCORPORATED

GENERAL OFFICES: HARRISBURG, PENNSYLVANIA

A-MP products and engineering assistance are available through wholly-owned subsidiaries in: Canada • England • France • Holland • Japan

THE LONG ARM OF

THE LABORATORY

He takes Laboratory designed electronic systems and evaluates them where they actually prove themselves. He makes this equipment produce everything that was designed into it. His title: Hughes Field Engineer.

Responsible for the modification and maintenance of complex Electronics Armament Systems and Guided Missiles, he keeps in the forefront of the newest electronics developments. Working with complete integrated systems, the Hughes Field Engineer learns how each component works toward the working, fighting total.

This highly respected professional engineer forms a critical link in a strong engineering chain. As an extension of the Hughes Research & Development Laboratories, it is his job to recommend modifications in the basic designs. At the same time, he maintains liaison with the manufacturing groups, making sure that the highest standards of reliability have been built into the system.

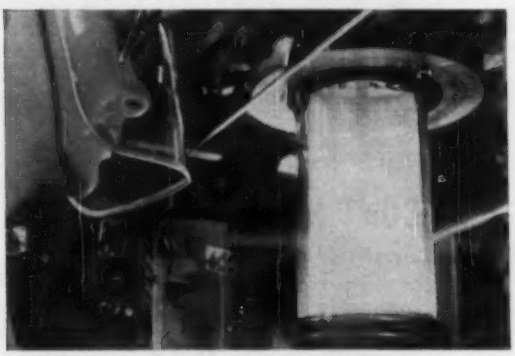
The chain of Research, Development, Manufacturing and Field Evaluation is also evident in other Hughes activities. The commercial products activity performs all these functions in the areas of electron tubes, semiconductor devices, and industrial systems and controls. The Ground Systems Division performs all phases on protective radar systems.

This attention to the highest standards of engineering, combined with the diversity and wide scope of activity, makes Hughes an ideal firm for the engineer or physicist interested in career advancement.

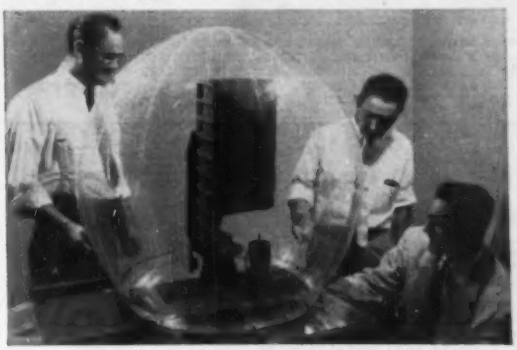
An immediate need now exists for engineers in the following areas:

Microwave Tubes	Radar
Engineering Writing	Communications
Semiconductors	Circuit Design
Field Engineering	Microwaves
Computer Engineering	Systems Analysis

Write, briefly outlining your experience, to Mr. Phil N. Scheid, Hughes General Offices, Bldg. 6-O-1, Culver City, California.



Molten Ladle of silicon is watched during first step in the precise manufacture of Hughes semiconductors. Constant innovations in Research, Development and Manufacture have positioned Hughes Products as a commercial electronics leader.



Electronic Scanning Radar systems, a radically new concept in radar beam positioning, is currently being developed and manufactured by the Hughes Ground Systems Division.

the West's leader in advanced electronics

HUGHES

HUGHES AIRCRAFT COMPANY
Culver City, El Segundo,
Fullerton and Los Angeles, California
Tucson, Arizona

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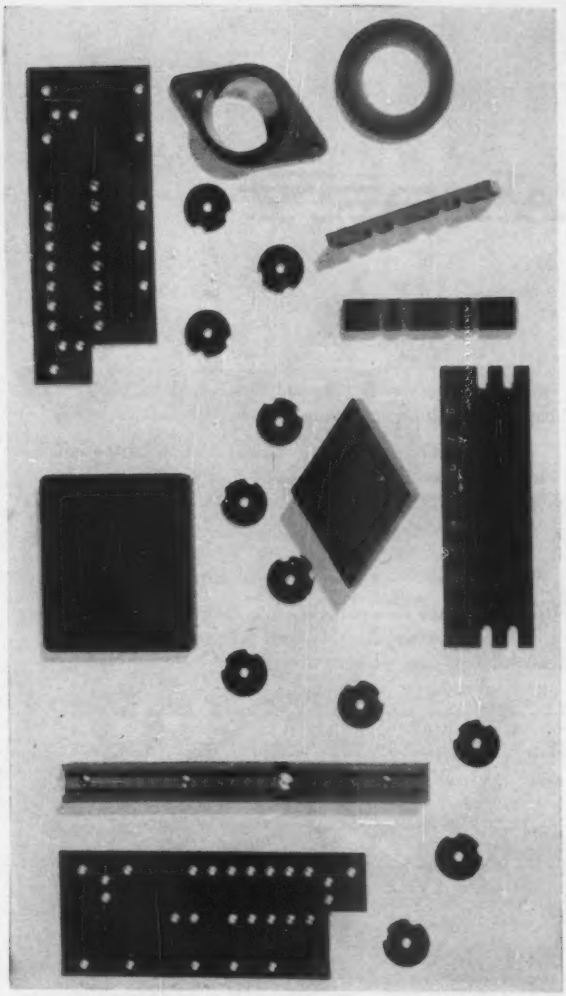


Fabricated by CDF. Near the presses that produced the Dilecto laminates, these paper-base parts were machined to close tolerances by CDF specialists . . . quickly, accurately, economically for the purchasers. This is a random selection from the five grades described in the table below.

CDF Dilecto® paper-base laminates for the workhorse insulation jobs

For everyday mechanical-electrical parts that receive tough punishment and must have excellent physical and dielectric properties at low cost, the CDF phenolic paper-base line is outstanding.

Economy. CDF paper-base grades machine readily into intricate parts. Some are flame-retardant. Others are especially adaptable for punching. All are economical for the value delivered.

Fabrication Facilities. CDF has excellent and extensive plastics-fabrication facilities for turning out finished Dilecto parts to your specifications—better and more economically than you can do it yourself. Save the time and trouble of intricate fabrication by using CDF's specialized facilities.

See Sweet's, Electronics Buyers' Guide, and the other directories for the phone number of the CDF sales engineer nearest you. Or send us your print or problem direct, and we'll return a recommendation of the right Dilecto grade for your need.

CDF makes Di-Clad® printed-circuit laminates, Diamond® Vulcanized Fibre, CDF products of Teflon†, flexible insulating tapes, Dilecto® laminated plastics, Celoron® molded products, Micabond® mica products, Spiral Tubing, Vulcoid®.

®Trademark of Continental-Diamond Fibre Corporation
†Du Pont trademark for its TFE-fluorocarbon resin

CONTINENTAL-DIAMOND FIBRE
A SUBSIDIARY OF THE Budd COMPANY • NEWARK 16, DEL.

Typical Property Values—Dilecto Paper-Base Laminates in Sheet Form

	X-13 (NEMA X)	XP-13 (NEMA P)	XX-13 (NEMA XX)	XX-13 FR (Fire-retardant) (NEMA XX)	XXXP-28 (NEMA XXXP)
ROCKWELL HARDNESS (M SCALE)	100	95	110	108	90
TENSILE STRENGTH lw (1000 psi.)	20	12	16	17	12
FLEXURAL STRENGTH lw (1000 psi.)	27	16	17	20	18
COMPRESSIVE STRENGTH (1000 psi.)	40	25	35	41	22
WATER ABSORPTION (% in 24 hrs.) 1/16" thickness	3.5	3.0	1.4	1.2	0.6
MAXIMUM CONTINUOUS OPERATING TEMPERATURE (°C.)	120	120	120	120	120
DIELECTRIC STRENGTH perp. to lam. (VPM)	800	800	650	700	800
DIELECTRIC STRENGTH parallel to lam. (Kv.)	50	50	60	70	75
DISSIPATION FACTOR at 1 mc, Cond. A	0.042	0.038	0.034	0.038	0.027
DIELECTRIC CONSTANT at 1 mc, Cond. A	5.5	4.6	4.7	4.8	3.6
ARC-RESISTANCE (seconds)	8	4	4	10	10
INSULATION RESISTANCE (megohms) ASTM D-257, Fig. 3	100	100	1,000	1,000	600,000
AIEE insulation class	A	A	A	A	A

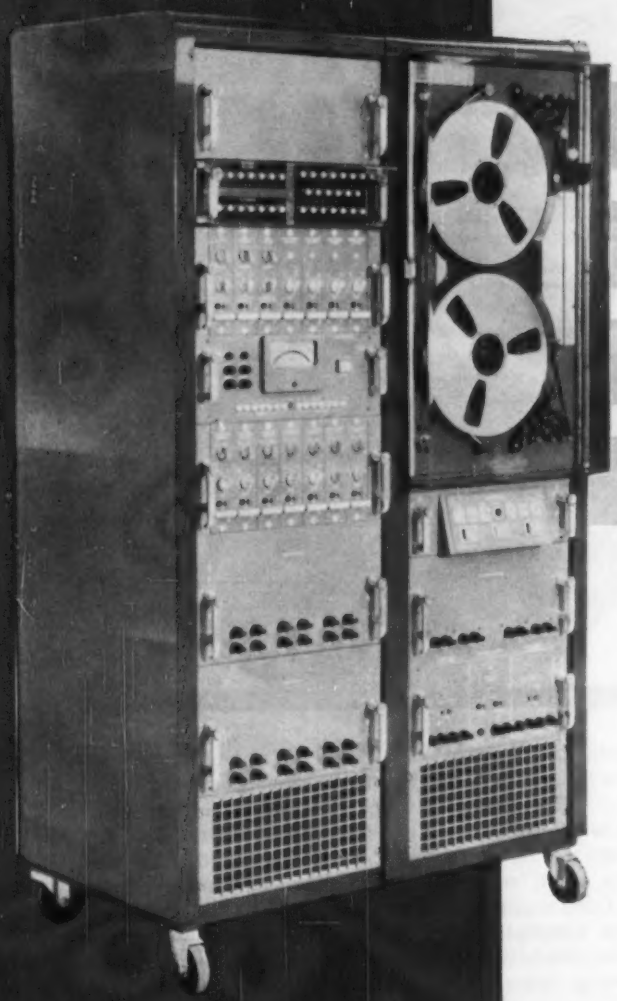
CIRCLE 50 READERS SERVICE CARD

CIRCLE 51 READERS SERVICE CARD→

MI

LEADING

"THE ADVANCEMENT OF THE ART"



COMPLETE SPECIFICATIONS ON REQUEST

MI

MODEL

707

Telemetering Ground Station Instrumentation Tape

START TIME
Less Than 30 Milliseconds

STOP TIME
Less Than 30 Milliseconds

FREQUENCY RESPONSE
To 130,000 cps

OUTPUT
4 volts rms into 180 ohms

RECORDER MODEL 707

New high standards of instrumentation tape recording are set by this Midwestern-Magnecorder which offers many tape widths and speeds.

Plug-in modules provide direct analog, PDM and FM recording. Simulaneous recording and reproduction of two tracks may be had on quarter-inch tape. Half-inch tape models provide seven tracks and one-inch models have fourteen tracks. Other configurations are available on special order.

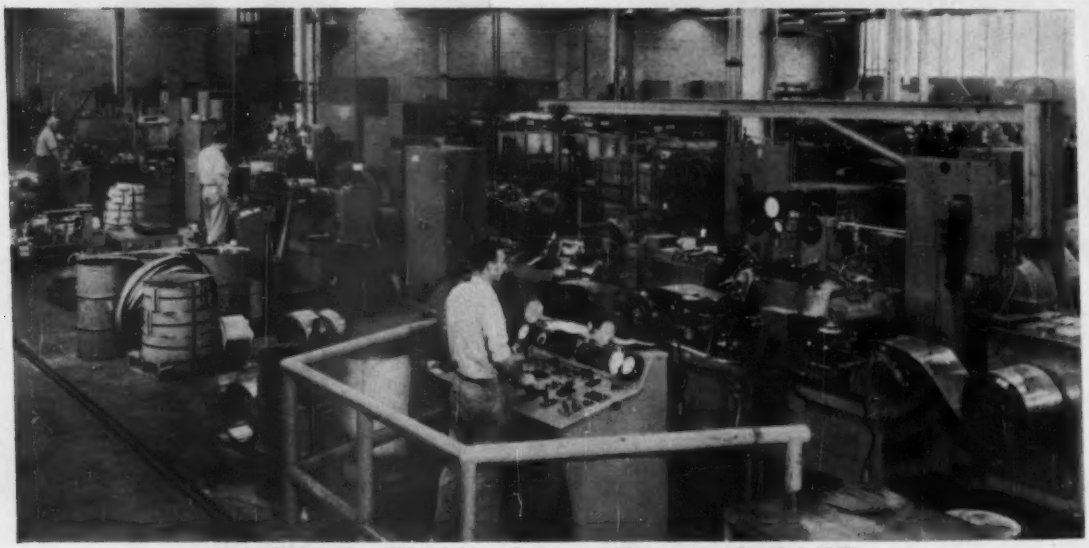
Ultra-precise all metal surface magnetic heads are of an exclusive design produced by Midwestern's Data Storage Devices Division.

MIDWESTERN INSTRUMENTS

41st AND SHERIDAN / TULSA, OKLAHOMA

General Plate Nifer®

Helps Wilbur B. Driver Company Provide Customers with Improved Radio Tube Material at Lower Cost



Sendzimer Mills at Wilbur B. Driver Company used for precision rolling G. P. NIFER

The well-known Wilbur B. Driver Company serves the electronic industry by supplying top quality tube materials such as filament and grid alloys, carbonized pure nickel strip and carbonized G. P. NIFER strip.

G. P. NIFER strip is low carbon steel faced on both sides with dense, heavy claddings of Grade 330 Nickel. Wilbur B. Driver Company cold rolls G. P. NIFER in Sendzimer Mills to precise thicknesses for customers who fabricate radio tube parts. And, reports Wilbur B. Driver Company, NIFER not only saves on material cost, but produces better carbonization, resulting in superior radio tube performance.

General Plate Division is constantly developing new clad metals which save weight, cut costs, increase strength, conserve materials in critical supply, improve performance and offer other advantages not found in single metals. Why not write today for catalog GP-1 and get acquainted with the potentials of G.P. Clad Metals in your products?

You can profit by using General Plate Clad Metals.

METALS & CONTROLS CORPORATION

General Plate Division

1310 Forest Street, Attleboro, Mass.

FIELD OFFICES: NEW YORK • CHICAGO • DETROIT • INDIANAPOLIS • MILWAUKEE • PASADENA

tubes cut costs of TV manufacture!

New 6AF3 and 12AF3 permit TV set-makers to profit more fully from economies of automated production.

Two new Tung-Sol damper diodes—6AF3 and 12AF3—bring TV manufacturers substantial dollar-savings through increased efficiency. Modern automatic assembly equipment is better able to process the miniature, button-stem dampers than prior octal-base types. Also, the new types allow standardization of tube and socket size—a big plus in printed circuit usage.

In addition to these cost-cutters, 6AF3 and 12AF3 offer premium performance. They approach the high ratings of the 6AU4GTA and 19AU4GTA . . . have the same heater power as the 6AX4GT and 12AX4GTA. Set-testing under actual overload conditions indicates the new tubes carry a greater "safety factor" than any previous damper.

The economy and top-flight quality of the 6AF3 and 12AF3 characterize the entire Tung-Sol tube line. For complete data on the new miniature dampers . . . to fill any entertainment socket, contact: *Tung-Sol Electric Inc., Newark 4, New Jersey.*

New Tung-Sol miniature dampers compared with types they replace

	BASING	LOAD-RATING	HEATER-RATING
6AF3 / 12AF3	Miniature	188ma*	6.3v, 1.2a / 12.6v, 0.6a
6AX4GT / 12AX4GTA	Octal	125ma†	6.3v, 1.2a / 12.6v, 0.6a
6AU4GTA / 19AU4GTA	Octal	190ma†	6.3v, 1.8a / 18.9v, 0.6a
12D4	Octal	145ma†	12.6v, 0.6a

*According to Design Maximum System of Ratings
†According to Design Center System of Ratings

TUNG-SOL®

Announcing

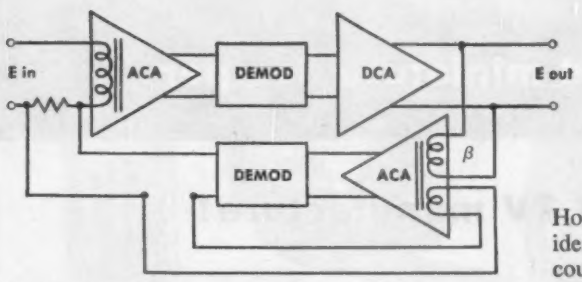
Honeywell
AccuData I d-c Amplifiers

Model 2HDH-61
shown approx. ½ size

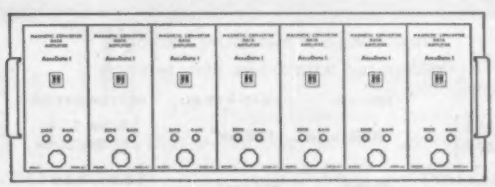
isolated differential input for strain gage, thermocouple and resistance bridge measurements

frequency response to 100 cps

100,000 ohm input resistance



The principal feature of this new development is a completely closed loop wideband feedback circuit which provides a highly accurate isolated signal connected in series opposition to the input emf.



The AccuData I d-c Amplifier is 5¼" high and is designed to mount seven to a 19" relay width. A frame assembly is available for this purpose. Separate power supplies (not shown) are used, having 2, 7, 14, or 49 channel capabilities.

Honeywell's new AccuData I d-c Amplifiers combine two Honeywell Second Harmonic Magnetic Converters to provide ideal d-c transducer preamplifier characteristics. Thermocouples, grounded or ungrounded; resistive strain gages operated from common power supplies; and other low-source impedance d-c devices are perfectly suited as inputs to this highly accurate d-c amplifier. The input circuit, with input impedance of greater than 100,000 ohms, is completely isolated from the output circuit and from ground.

The output is single-ended to match emf-input analog-to-digital converters. Overall non-linearity is 0.01%; gain instability, drift, and noise are less than 0.1%.

Other specifications: Response down 3 db at 100 cps; Rise time to 99.9% = 30 milliseconds; Input: 0 to 5 mv; Output: 0 to 1.0 volt; Output impedance: 0.01 ohms; Common Mode Rejection: at d-c virtually infinite; at 60 cps: 130 db (3,000,000 to 1).

Write for technical bulletin on the AccuData I, Model 2HDH-61, to Minneapolis-Honeywell, Boston Division, Department 7, 40 Life Street, Boston 35, Massachusetts.

Honeywell

H HONEYWELL *First in Control*

SILICON ZENER DIODES!

for every circuit!

VOLTAGE REGULATOR TYPES

	INT.L DIODE TYPE	ZENER VOLTAGE RANGE	I_Z MAX. ma	DYNAMIC IMPEDANCE Z_Z (OHMS)	DYNAMIC IMPEDANCE @ I_Z ma	NOMINAL TEMP. COEFFICIENT %/°C
500 MILLIWATT TYPES MINIATURE STYLE M	MZ 3.9	3.6–4.3	125	1.5	25	−.04
	MZ 4.7	4.3–5.1	100	1.5	20	0
	MZ 5.6	5.1–6.2	90	2.3	17.5	+.03
	MZ 6.8	6.2–7.5	75	3	15	+.05
	MZ 8.2	7.5–9.1	60	4.5	12.5	+.06
	MZ 10	9.1–11	50	6.8	10	+.07
	MZ 12	11–13	40	12	7.5	+.075
	MZ 15	13–16	33	23	6	+.08
	MZ 18	16–20	27	45	5	+.085
	MZ 22	20–24	23	70	4.5	+.09
	MZ 27	24–30	18	90	3.5	+.095
1 WATT TYPES STYLE S Pigtail Construction	1Z 3.9	3.6–4.3	250	1	50	−.04
	1Z 4.7	4.3–5.1	200	1	40	0
	1Z 5.6	5.1–6.2	175	1.5	35	+.03
	1Z 6.8	6.2–7.5	150	2	30	+.05
	1Z 8.2	7.5–9.1	120	3	25	+.06
	1Z 10	9.1–11	100	4.5	20	+.07
	1Z 12	11–13	80	7.5	15	+.075
	1Z 15	13–16	65	15	13	+.08
	1Z 18	16–20	55	30	10	+.085
	1Z 22	20–24	45	45	9	+.09
	1Z 27	24–30	35	60	7	+.095
3.5 WATT TYPES STYLE Y Stud Construction	3Z 3.9	3.6–4.3	850	.5	150	−.04
	3Z 4.7	4.3–5.1	700	.5	125	0
	3Z 5.6	5.1–6.2	625	.75	110	+.03
	3Z 6.8	6.2–7.5	525	1	100	+.05
	3Z 8.2	7.5–9.1	425	1.5	80	+.06
	3Z 10	9.1–11	350	2.5	70	+.07
	3Z 12	11–13	275	4	50	+.075
	3Z 15	13–16	225	7.5	40	+.08
	3Z 18	16–20	200	15	35	+.085
	3Z 22	20–24	160	22.5	30	+.09
	3Z 27	24–30	125	30	25	+.095
10 WATT TYPES STYLE T Stud Construction	10Z 3.9	3.6–4.3	2500	.25	500	−.04
	10Z 4.7	4.3–5.1	2000	.25	400	0
	10Z 5.6	5.1–6.2	1750	.4	350	+.03
	10Z 6.8	6.2–7.5	1500	.5	300	+.05
	10Z 8.2	7.5–9.1	1200	.75	250	+.06
	10Z 10	9.1–11	1000	1.25	200	+.07
	10Z 12	11–13	850	2	170	+.075
	10Z 15	13–16	650	4	140	+.08
	10Z 18	16–20	550	7.5	110	+.085
	10Z 22	20–24	450	12	90	+.09
	10Z 27	24–30	350	15	70	+.095
DOUBLE ANODE TYPES 330 MILLIWATT	ZZ 3.9	3.6–4.3	110	3	22	−.045
	ZZ 4.7	4.3–5.1	90	4	18	−.01
	ZZ 5.6	5.1–6.2	70	5	14	0
	ZZ 6.8	6.2–7.5	60	10	12	+.025
	ZZ 8.2	7.5–9.1	50	15	10	+.035
	ZZ 10	9.1–11	40	25	8	+.05
	ZZ 12	11–13	30	40	7.5	+.06
	ZZ 15	13–16	25	60	5	+.07
	ZZ 18	16–20	20	80	4	+.08
	ZZ 22	20–24	16	125	3.5	+.09
	ZZ 27	24–30	13	200	3	+.095
MULTIPLE JUNCTION TYPES HIGH VOLTAGE 5 WATT	HZ 27	24– 30	200	7	40	0
	HZ 33	30– 36	150	10	30	+.03
	HZ 47	43– 51	110	20	22	+.06
	HZ 68	62– 75	75	50	14	+.075
	HZ100	91–110	50	180	10	+.085
	HZ150	130–160	35	370	7	+.095

REFERENCE ELEMENT TYPES

IN430	8.0–8.8	50	15	10	±.002 −55°to+100°C
IN430A	8.0–8.8	50	15	10	±.001 −55°to+100°C
IN430B	8.0–8.8	50	15	10	±.001 −55°to+150°C

International Rectifier Corp.

XV Plot of Reverse Breakdown Characteristics Supplied with Each Diode!

Here's the *versatile* zener line—a type for every application—coupled with a new service conceived to conserve engineering time! Excellent characteristics, especially in terms of low impedance values, hermetic sealing, all-welded construction and a high thermal capacity package qualify these diodes for your consideration. Receiving a plot of characteristics *with each diode* eliminates guesswork and tedious testing on your part—means more time for creative engineering. Inquire further about these diodes...and the special application services we are prepared to offer you.

EXECUTIVE OFFICES: EL SEGUNDO, CALIFORNIA • PHONE OREGON 8-6281 • CABLE RECTUSA

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CIRCLE 55 READERS SERVICE CARD

Teleprinted Communications . . . on the double!

The Kleinschmidt teletypewriter set sends teleprinted messages from tape at speeds up to 100 words per minute.
AT THE SAME TIME, on the same unit, the operator perforates and prints other messages for transmission.

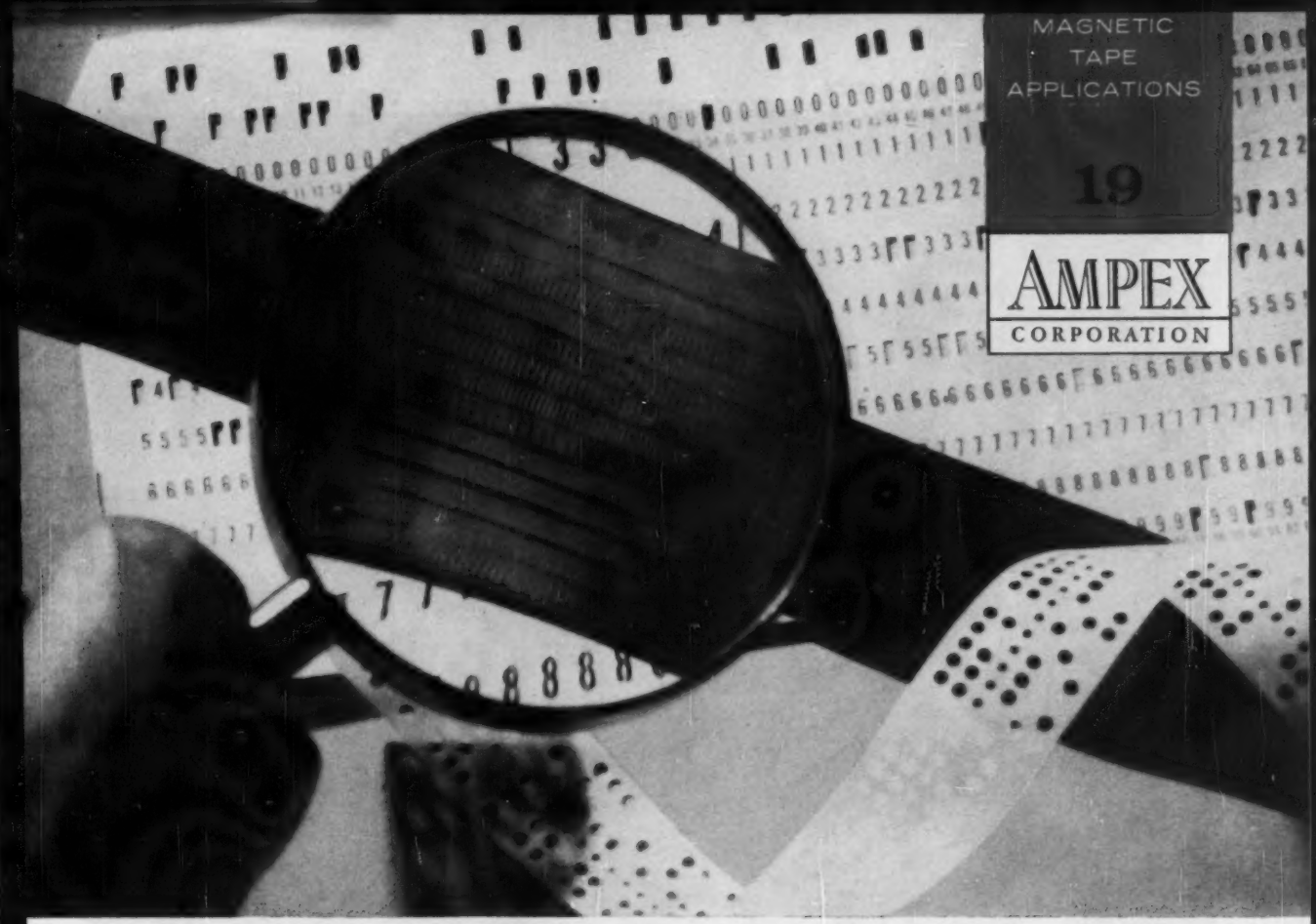
Day after day, Kleinschmidt teletypewriters and related equipment at U. S. Army Communication Centers receive and transmit thousands of teleprinted messages. This tremendous communications traffic, accelerated by multiple-function Kleinschmidt equipment, developed in cooperation with the U. S. Army Signal Corps, flows smoothly and precisely. Both sender and recipient receive a teleprinted original, identical in every respect.

Since the century began, the Kleinschmidt name has been associated with every major development in teleprinted communications. Now a member of the Smith-Corona family, Kleinschmidt looks ahead to new attainments in broadening the field of electronic communications for business and industry.

KLEINSCHMIDT

DIVISION OF SMITH-CORONA MARCHANT INC., DEERFIELD, ILL.

Pioneer in teleprinted communications systems and equipment since 1911



When to use magnetic tape in automatic control

Iron dust and a magnifying glass provide a revealing visual comparison

You are seeing iron dust clinging to signals recorded on magnetic tape. There can be 3200 extremely reliable binary bits on one square inch—or analog control information similarly compact. In the compacting of automatic control data, magnetic tape is supreme—second only to nature's remarkable chromosome. Nature makes people, dogs, cats and monkeys. Magnetic tape recorders make, for example, machined parts—their shapes the most complex and precise that have ever been produced in quantity. It is done by numerical control. The principles involved are very widely applicable to all kinds of control applications. Three main criteria determine where magnetic tape is your best choice.

Criteria No. 1: QUANTITY OF CONTROL DATA

Any automatic control operation that can benefit from very large numbers of time-synchronized commands is a natural candidate for magnetic tape. For example, continuous-path control of a milling cutter may require X, Y and Z coordinates at several hundred points per inch of tool movement. The more points, the greater the accuracy. A reel of magnetic tape can define millions of points at extremely low unit cost.

Continuous real-time control of variables is applicable to process programming, simulation devices, automatic inspection and electronic-system checkout—provided there is need for great accuracy in a complex situation. The program tapes may incorporate the work of giant computers and intricate interpolating devices. A great advantage of magnetic tape is that the computer and interpolator are used only during tape preparation, hence may be shared with many other needs.

Criteria No. 2: HIGH TRANSFER RATE

The Ampex FR-300 digital tape handler can spew out alpha-numeric characters at rates as high as 30,000 to 90,000 per second. A short burst of digital information equivalent to a standard punched card can be extracted from magnetic tape under 4 milliseconds—including start and stop.

On analog position-control data, magnetic tape can provide many hundreds of complete commands per second—200 per second in one example and up to eight times this many if needed.

On control-system monitoring, a recording of as much as two hours duration can be played back in one minute for review by high-speed computers. Ampex tape recorders with overall speed ratios as high as 120-to-1 are available.

Criteria No. 3: ERASURE AND RE-RECORDING

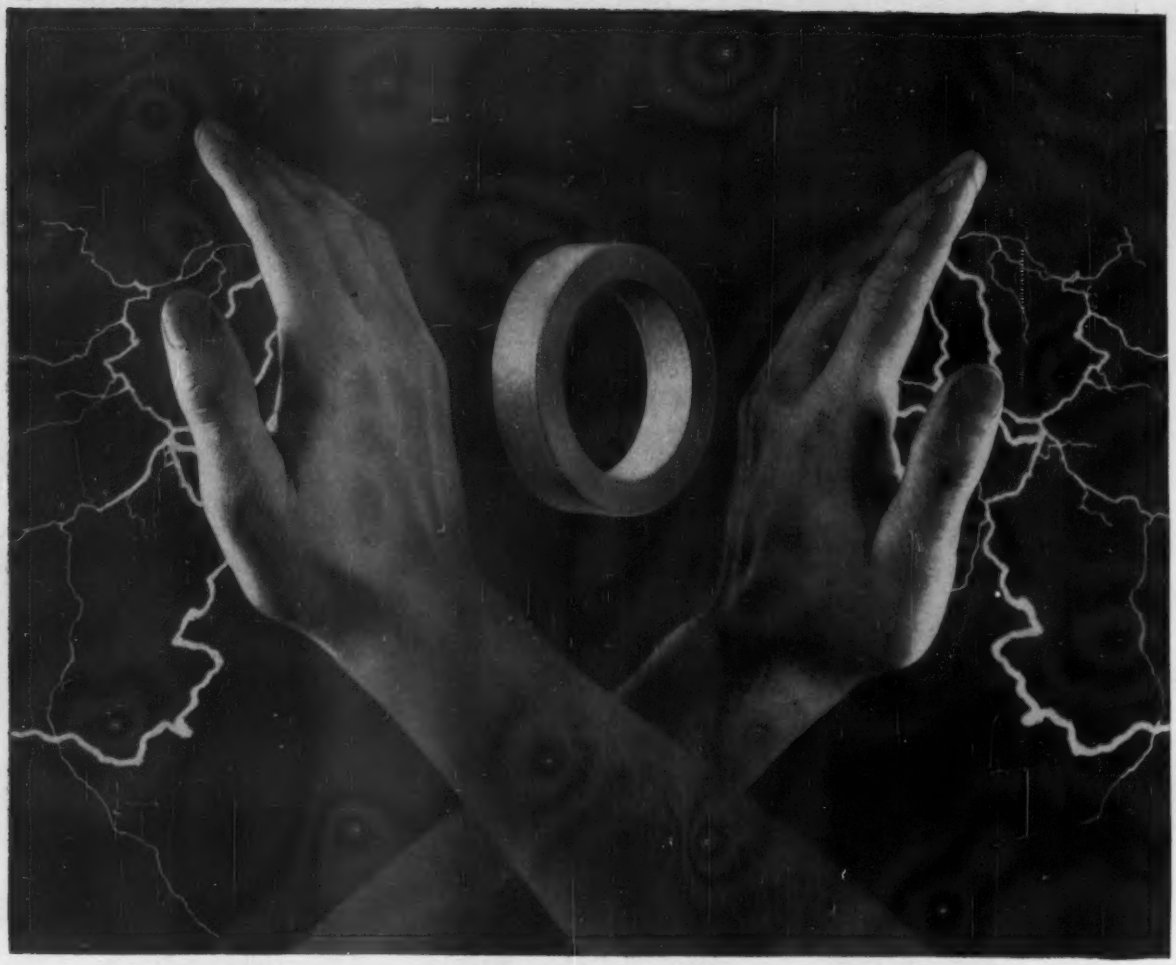
Magnetic tape can be erased to accept new data an endless number of times. Hence tape-loop recorders can operate on a repetitive cycle of recording, reproduction, erasure and re-recording to serve as time-delay devices or endless monitors. Such a loop can be the analog equivalent of a production line, conveyor belt or process flow. The loop keeps in step, accepts sensing information at one place and then triggers commands at some fixed time downstream. Or as a calamity monitoring device, the tape loop stores information briefly and erases it to make way for new data if nothing has occurred.

Can we advise you on a specific application of magnetic-tape control or send further literature on magnetic-tape recorder principles and applications? Write Dept. E-19.

AMPEX INSTRUMENTATION DIVISION • 860 CHARTER STREET • REDWOOD CITY, CALIFORNIA

Phone your Ampex data specialist for personal attention to your recording needs. Offices serve U. S. A. and Canada. Engineering representatives cover the free world.

CIRCLE 57 READERS SERVICE CARD



GUARANTEED TO WITHSTAND 1,000 VOLTS!

GVB-finished tape wound core boxes drop your production costs

We have developed a radical new finish for aluminum boxes for tape wound cores. Your production department will glow with delight, for we guarantee this finish to withstand 1,000 volts (at 60 cycles) without taping!

GVB, for Guaranteed Voltage Breakdown (limits), is what we call this new finish. It is perfectly matched to our aluminum core boxes, for it will withstand temperatures from –70°F to 450°F. Potting techniques need not change, for GVB-finish lives happily with standard potting compounds.

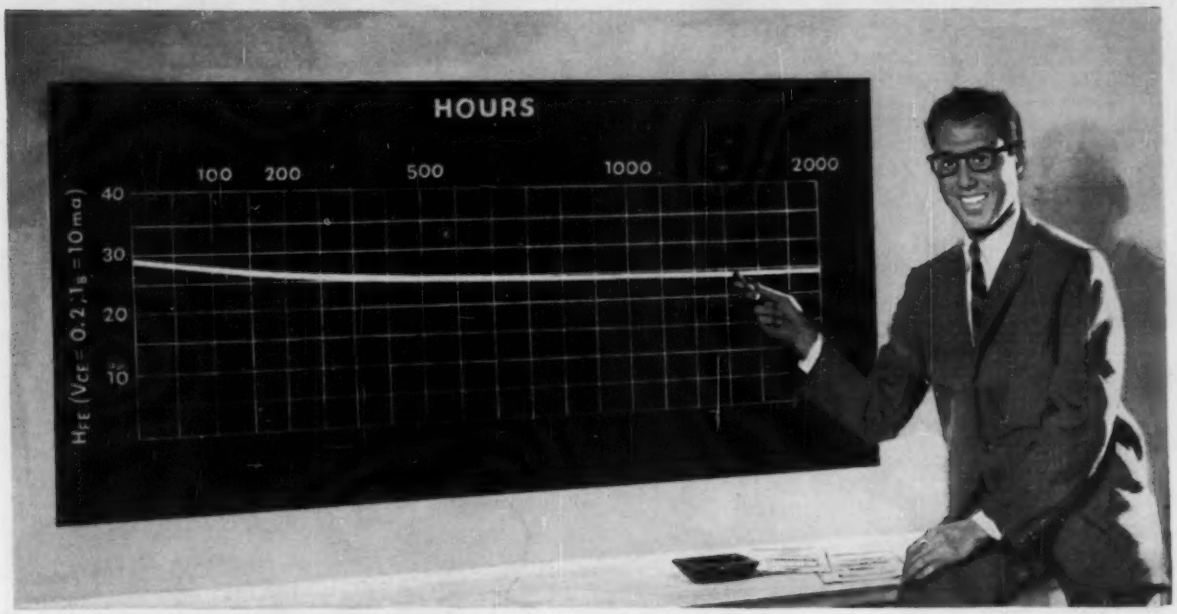
By eliminating the need for taping the core box, you also eliminate a time consuming production step. By combining GVB-finish with our aluminum core box, we assure you a core capable of being vacuum impregnated down to 20 mm. of mercury.

And they are Performance-Guaranteed! Like all tape wound cores from Magnetics, Inc., aluminum-boxed or phenolic-boxed, you buy them with performance guaranteed to published limits. The maximum and minimum limits are for B_m, B_r/B_m, H_l and gain. This data is published for one, two, four and six mil Orthonol® and Hy Mu 80 tape cores.

GVB-finished cores are ready for you now. So are the published limits for all Magnetics, Inc. tape wound cores. Write today for more GVB details, and for your copy of the guaranteed performance limits: Dept. **E-51,** Magnetics, Inc., Butler, Pennsylvania.

MAGNETICS inc.

SYLVANIA–NPN SWITCHING TRANSISTORS

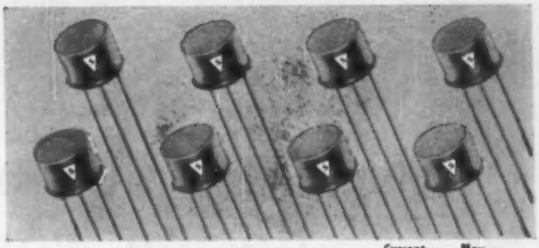


...still holding the line at 2000 hours

Eight new high stability NPN switching transistors designed for wide application in low and medium power switching circuits, are now available from Sylvania. They increase to 15, the total number of NPN switching types in the Sylvania line. Most of the units now have passed 2,000-hour evaluations and are continuing to maintain the high Beta stability and fast rise time so important in switching applications.

The fifteen NPN germanium transistors include both *base-on-the-can* types with *150 mw and 200 mw dissipation* and *base-off-the-can* types with *100 mw dissipation.*

Each of the types features the Sylvania welded hermetic seal for full protection against humidity and other environmental conditions and meets JETEC TO-5 and TO-9 dimensions. For further particulars on the entire line, contact your Sylvania representative or write Sylvania direct.



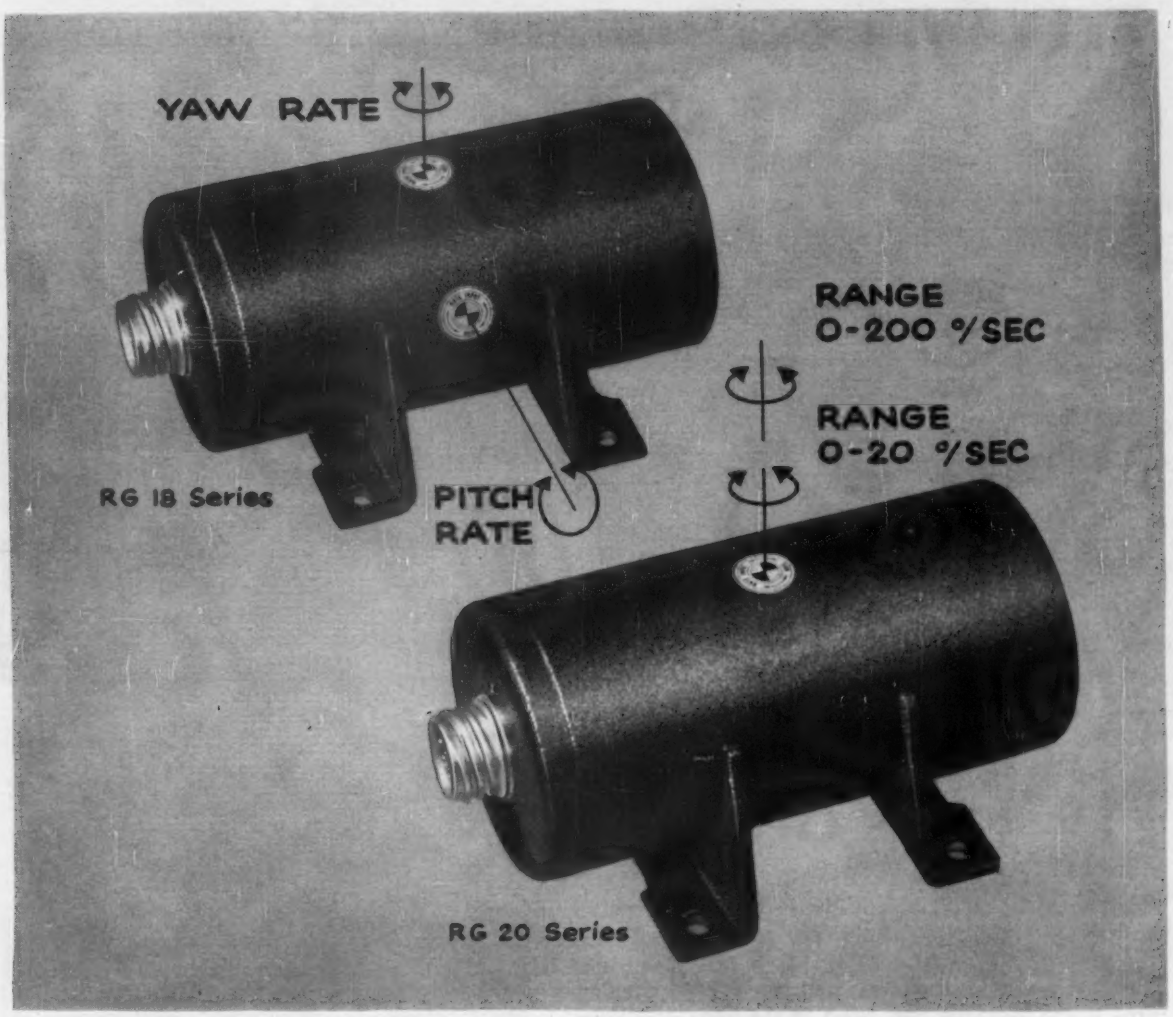
Type	Max. Dissipation at 25° Ambient	Max. Junction Temp. (°C)	Max. I_c (ma)	Current Gain h_{FE}	Max. Rise Time, t_r
2N439	100 Mw	85	100	40	2.5 usec
2N556	100 Mw	85	200	50	3.5
2N557	100 Mw	85	200	30	6.5
2N558	100 Mw	75	200	75	3.5
2N576*	200 Mw	100	400	40	2.0
2N576A*	200 Mw	100	400	80	2.0
2N587*	150 Mw	85	200	30	2.0
2N679*	150 Mw	85	100	20	3.0
2N312	100 Mw	85	200	20	1.5
2N256	100 Mw	85	500	30	2.0
2N257	100 Mw	85	500	30	1.2
2N258	100 Mw	85	500	30	0.8
2N377*	150 Mw	100	200	40	2.5
2N385*	150 Mw	100	200	70	–
2N388*	150 Mw	100	200	110	1.0

*Base internally connected to the case

SYLVANIA

SYLVANIA ELECTRIC PRODUCTS INC.
1740 Broadway, New York 19, N. Y.
In Canada: Sylvania Electric (Canada) Ltd., P. O. Box 1190, Station "O," Montreal 9

LIGHTING • TELEVISION • RADIO • ELECTRONICS • PHOTOGRAPHY • ATOMIC ENERGY • CHEMISTRY-METALLURGY



New Humphrey dual-rate gyros do the work of two units

Now important reductions in the space required for instrument and control packages can be made with the introduction of a new Humphrey rate gyro that replaces two ordinary gyros. The new design utilizes a single motor to drive two separate wheels in one unit. With this new development, it is possible to measure rates about two different axes with an RG-18 Series Gyro or cover two different rate ranges about the same axis with a single RG-20 Series instrument.

RG-18 gyros should find widespread use for applications now requiring two instruments. For example, one unit could be used to measure both pitch and yaw. The RG-20 Series, with its two different rate ranges, may be applied to instrumentation systems where greater accuracy is required. For example, a single unit can be furnished to cover the rate ranges from 0—20 degrees/second and from 0—200 degrees/second. In effect, you expand the dynamic range of your instrumentation system from 100 to 1 to 500 to 1. This expanded scale gives you far greater accuracy.

The new rate gyros are built with two independent pick-offs—one for each axis or one for each range. They meet tough environmental conditions, such as temperature from −65°F to 180°F while operating, relative humidity 100%, unlimited altitude and excellent resistance to acceleration, vibration and shock. Phone or write today and let the kind of engineering that developed these new dual-rate gyros go to work for you.

Humphrey Inc.

ELECTRO-MECHANICAL INSTRUMENTS

DEPT. E-108, 2805 CANON STREET
SAN DIEGO, CALIFORNIA

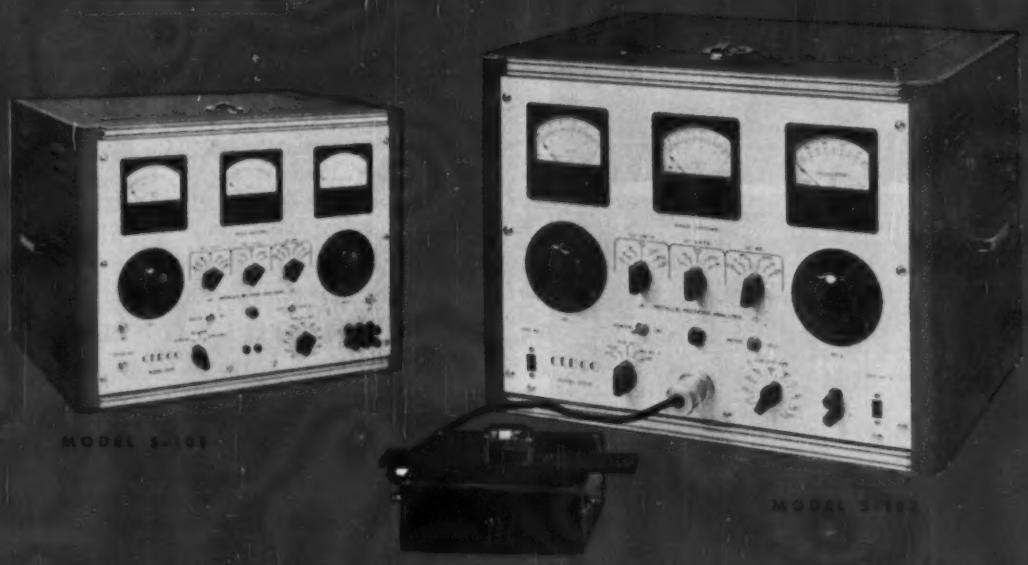
FOR COMPLETE SYSTEMS, SPECIFY HUMPHREY
GYROSCOPES, ACCELEROMETERS, POTENTIOMETERS

NOW-

RAPID ACCURATE TESTING OF

SILICON
GERMANIUM
SELENIUM

RECTIFIERS and DIODES



WITH THE NEW Cedco METALLIC RECTIFIER ANALYZERS

FEATURING

5 STANDARD CIRCUIT TESTS

1. **Visual dynamic voltage-current characteristic.**
2. **Dynamic reverse-current leakage.**
3. **Dynamic forward-voltage drop.**
4. **Static reverse-current leakage.**
5. **Static forward-voltage drop.**

NOW . . . for the first time, production and laboratory users of power rectifiers and signal diodes may perform *five* standard circuit tests with *one* precision instrument . . . the CEDCO Metallic Rectifier Analyzer.

Versatile, accurate and rapid, the new CEDCO Analyzer exceeds the highest standards of engineering quality. Three Weston meters, accurate within 1%, AC Voltmeter (0 to 1500 V.), DC Voltmeter (0 to 1000 V.) and DC Milliammeter (0 to 10 AMP.) assure dependable performance.

Model S-101—Self-contained featuring complete set of plug-in adapters, accepting wide range of sizes.

Model S-102—Ideal for laboratory use. Adjustable test fixture for remote testing permits shelf mounting away from the working area.

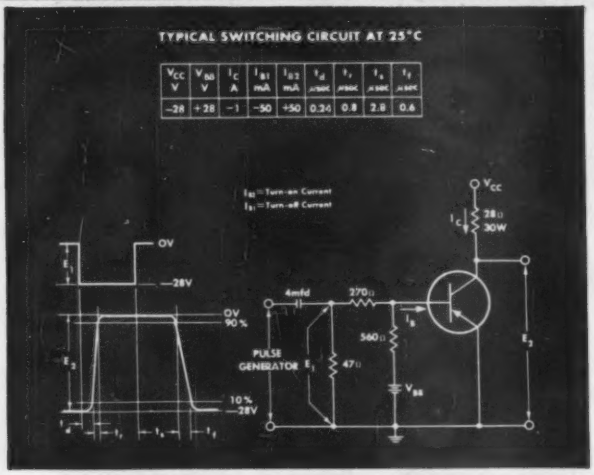
Illustrated brochure, Bulletin R-250, is available upon request.

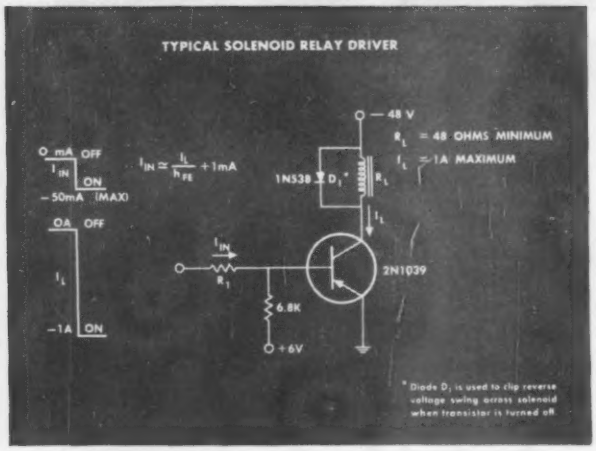
Eastern Regional Sales Office:
Wilson Building
Camden, New Jersey

Cedco ELECTRONICS
TESTVILLE, PENNSYLVANIA

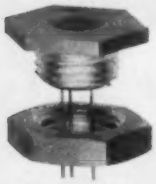
DESIGNERS AND MANUFACTURERS OF PRECISION ELECTRONIC TEST EQUIPMENT

INDUSTRY'S BROADEST LINE OF





NEW POWER SWITCHING TRANSISTORS


(ACTUAL SIZE)

NEW P-N-P germanium power switching transistors *guarantee* 5.5 W dissipation at 25°C with voltage ratings of 40, 60, 80, and 100 volts for optimum design flexibility. The functional design of the heat sink assures rapid installation requiring only one mounting hole through the chassis.

You get *guaranteed* 20-to-60 beta spread and a low 0.16 ohm saturation resistance at the 3A maximum collector rating. In addition, a maximum 125 μA collector reverse current is *guaranteed* at one-half rated breakdown voltage with TI 2N1042, 2N1043, 2N1044, and 2N1045 alloy junction transistors.

These new devices are well suited for your switching circuits . . . relay drivers . . . audio and pulse amplifiers.

NEW MEDIUM POWER SWITCHING TRANSISTORS

(ACTUAL SIZE)

NEW P-N-P germanium medium power transistors give you switching times as low as 1.1 μsec. TI 2N1038, 2N1039, 2N1040, and 2N1041 alloy junction transistors provide 800 mW dissipation in free air at 25°C, 450 mW at 55°C . . . with voltage ratings of 40, 60, 80, and 100 volts.

In addition, *guaranteed* 20-to-60 beta spread and low 0.2 ohm saturation resistance assure reliable performance for your high speed switching circuits . . . relay drivers . . . low power audio and pulse amplifiers.

		Type	Dissipation at 25°C	Collector Voltage-V max	Collector Current A max	Beta min	Beta max	Collector Reverse Current I_{CO} max μA	Collector Reverse Current I_{CO} max V	Saturation Resistance Ohm
computer power	pnp	2N1046	15W	−80	−3	40	70 (Avg)	−1mA	−40	0.75
medium power		2N1038	800mW	−40	−1	20	60	−125	−20	0.2
	pnp	2N1039	800mW	−60	−1	20	60	−125	−30	0.2
		2N1040	800mW	−80	−1	20	60	−125	−40	0.2
		2N1041	800mW	−100	−1	20	60	−125	−50	0.2
power		2N456	50W	−40	−5	30@5A avg.		−2mA	−40	0.048
	pnp	2N457	50W	−60	−5	30@5A avg.		−2mA	−60	0.048
		2N458	50W	−80	−5	30@5A avg.		−2mA	−80	0.048
		2N1021	50W	−100	−5	23@5A avg.		−2mA	−100	0.08
		2N1022	50W	−120	−5	23@5A avg.		−2mA	−120	0.08
		2N1042	5.5W	−40	−3	20	60	−125	−20	0.16
		2N1043	5.5W	−60	−3	20	60	−125	−30	0.16
		2N1044	5.5W	−80	−3	20	60	−125	−40	0.16
		2N1045	5.5W	−100	−3	20	60	−125	−50	0.16

IMMEDIATELY AVAILABLE IN PRODUCTION QUANTITIES OR . . .

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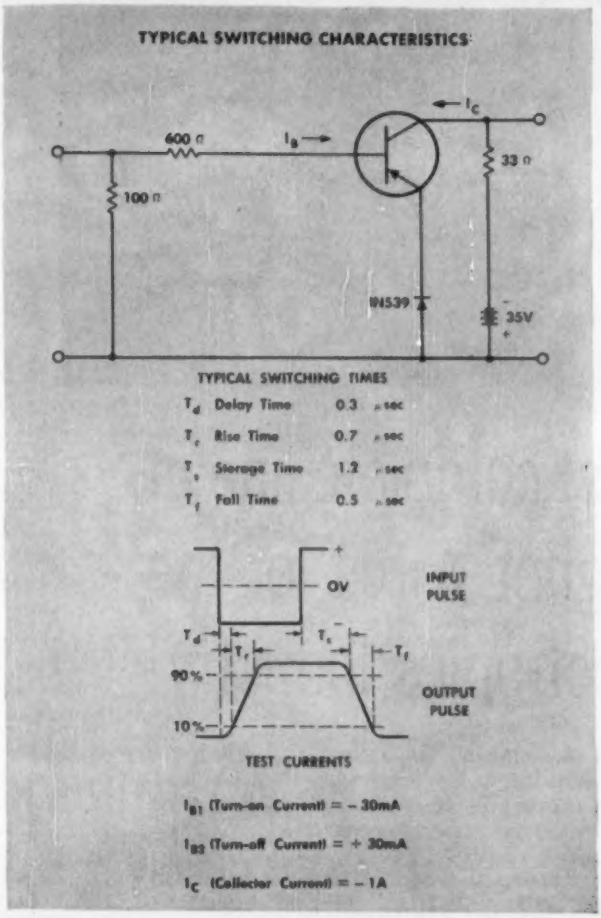
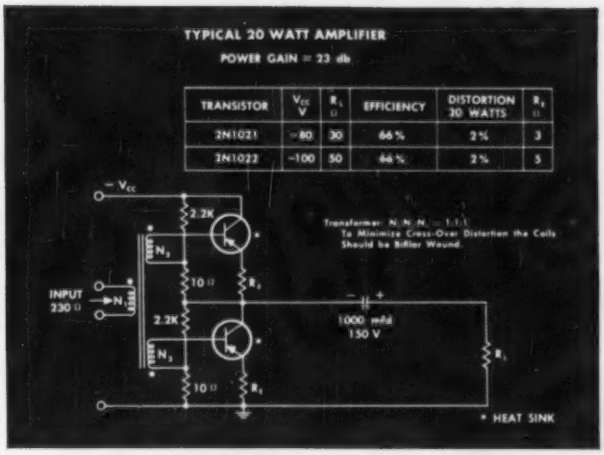
WORLD'S LARGEST SEMICONDUCTOR PLANT

CIRCLE 93 READERS SERVICE CARD

GERMANIUM POWER TRANSISTORS!




TYPICAL 20 WATT AMPLIFIER
POWER GAIN = 23 db
TRANSISTOR | V_{CC} V | R_L Ω | EFFICIENCY | DISTORTION 20 WATTS | R_L Ω
2N1021 | −80 | 30 | 66% | 2% | 3
2N1022 | −100 | 50 | 66% | 2% | 5
$-V_{CC}$
2.2K
N_2
10 Ω
R_1
INPUT 230 Ω
N_1
2.2K
N_3
10 Ω
R_1
1000 mfd 150 V
R_L
Transformer: $N_1:N_2:N_3 = 1:1:1$
To Minimize Cross-Over Distortion the Coils Should be Bifilar Wound.
* HEAT SINK

NEW HIGHEST FREQUENCY COMPUTER POWER TRANSISTOR

(ACTUAL SIZE)

NEW TI 2N1046 combines *high power, high frequency* and *high voltage* performance in a single transistor package! This P-N-P diffused base germanium transistor has *guaranteed* dissipation to 15 watts and collector breakdown voltage to 80 volts with 12 mc typical alpha cutoff. Extremely low collector reverse current averaging 0.2 ma at 40 volts and a low 0.75 ohm saturation resistance assure reliable operating characteristics.

Designed for your deflection circuits and computer core driving applications, the 2N1046 has a typical 10mc internal cutoff frequency, f_T (point at which forward current transfer ratio equals unity).

NEW HIGHEST VOLTAGE TRANSISTORS

(ACTUAL SIZE)

NEW TI 2N1021 and 2N1022 germanium transistors, *with maximum operating voltages of 100 V and 120 V respectively,* provide typical betas of 70 at 1A . . . 23 at 5A!

You get *guaranteed* 700 μA maximum collector reverse current at one-half rated voltage and 2mA maximum at full rated voltage in addition to extremely low saturation resistance . . . 0.08 ohm R_{CS}.

For your audio, servo and power applications, consider these outstanding performance characteristics and specify TI germanium transistors.

OFF THE SHELF IN 1-99 QUANTITIES FROM YOUR NEARBY TI DISTRIBUTOR

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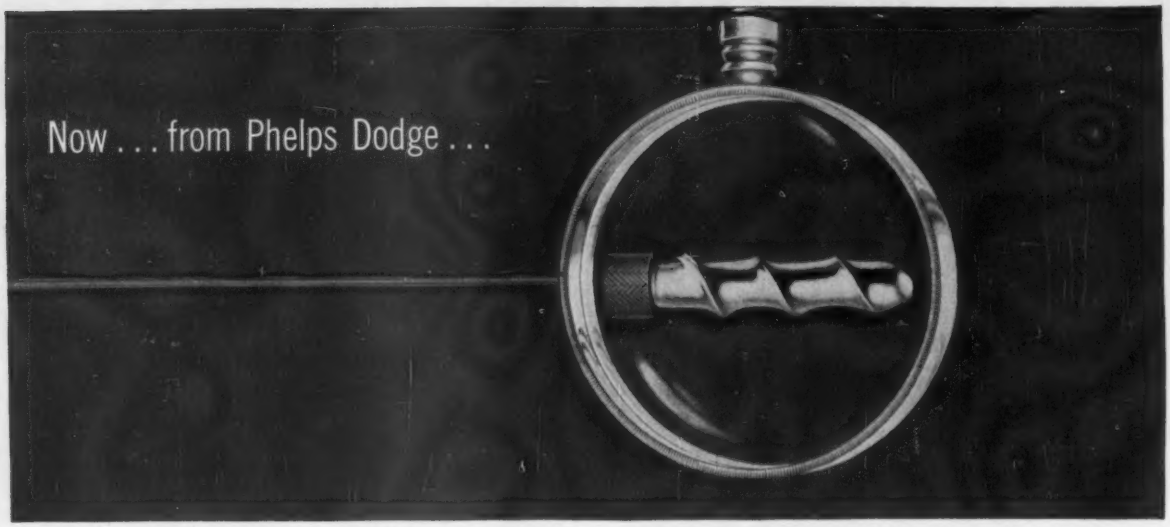


First complete line of Solderable Magnet Wires for the Electronics Industry!

S-Y BONDEZE® — answers the long-awaited need for a self-bonding wire that is solderable at low temperatures. The high temperature cut-thru resistance of the underlying film will reduce the number of shorts in your coils.

NYLEZE® — a tough, all-purpose, solderable wire for your most severe applications. Especially suited for use in high speed automatic winding equipment or wherever extreme varnish or compound treatment is involved.

SODEREZE® — the magnet wire that is solderable at low temperature, proven over the years in thousands of customer applications.

GRIP-EZE® — a solderable film wire with controlled surface friction for use in lattice-wound coils. A special surface treatment provides mechanical gripping between turns and keeps the wire in place.

All Phelps Dodge *solderable* magnet wires are red in color.

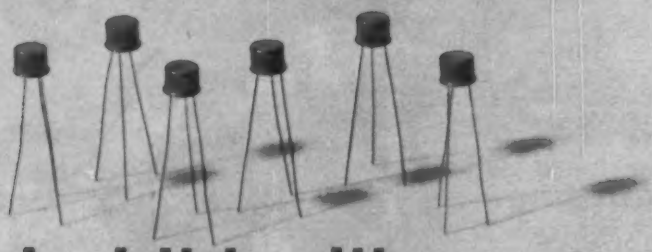
Any time your problem is magnet wire, consult Phelps Dodge for the quickest, easiest answer!

FIRST FOR LASTING QUALITY —FROM MINE TO MARKET!

PHELPS DODGE COPPER PRODUCTS CORPORATION

INCA MANUFACTURING DIVISION

FORT WAYNE, INDIANA



Fairchild silicon transistors

Milli-micro-second switching speeds and high current too

Where applications require transistor performance beyond previously accepted high limits, Fairchild Silicon Transistors offer an exceptional three-way combination:

1) 50 milli-micro-second typical rise time — permits faster switching rates in computing devices. Total switching time is typically 0.2 microseconds.

2) 1 watt dissipation at 100° C. — Saturation resistance is 10 ohms maximum. Resulting high-current capability provides opportunities to increase equipment performance while reducing circuit complexity.

3) Silicon temperature performance — Maximum junction temperature of 175° C. gives low leakage and more safety factor at any lower temperature.

These characteristics are the outcome of the solid-state diffusion technique used at Fairchild. Other important accomplishments of this process are excellent reliability and a high order of electrical uniformity throughout large production runs.

The accomplishment of a research-production team
Singleness of purpose did it. Fairchild assembled a uniquely experienced team of research scientists and production engineers whose objective was to bring the advanced solid-state diffusion process under close control. They succeeded in putting laboratory-quality silicon transistors into quantity manufacture with firm product specifications exceeding anything previously offered.

2N696 and 2N697 SILICON TRANSISTORS

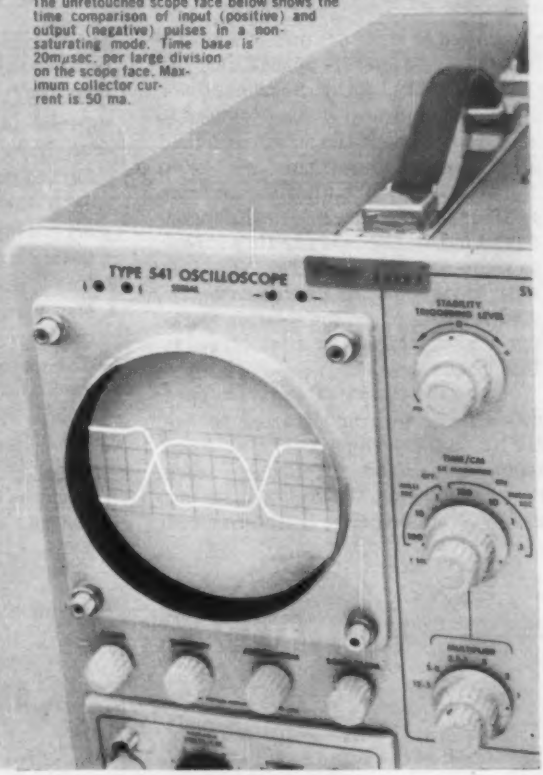
Symbol	Specification	Rating	Characteristics	Test Conditions
V_{CE}	Collector to Emitter voltage (25° C.)	40v		
P_C	Total dissipation Case temp. 25° C. Case temp. 100° C.	2 watts 1 watt		
h_{FE}	D.C. current gain		2N696 — 15 to 30 2N697 — 30 min.	I_C=150ma V_C=10v
R_{CS}	Collector saturation resistance		6Ω typical, 10Ω max.	I_C=150ma I_B=15ma

For full information and specifications, write Dept. A-10

FAIRCHILD
SEMICONDUCTOR CORPORATION

844 CHARLESTON ROAD • PALO ALTO, CALIFORNIA

The unretouched scope face below shows the time comparison of input (positive) and output (negative) pulses in a non-saturating mode. Time base is 20mμsec. per large division on the scope face. Maximum collector current is 50 ma.



STOPPED *making our own etchant* STARTED *using* HUNT S.C.E.

"We used to make our own etchant for solder plated circuit boards until we heard of HUNT S.C.E. Solution.

"To mix our own etchant we used to stock large quantities of chromic and sulphuric acid. It took time to make up the solutions which filled the air with noxious fumes and was always dangerous to handle. Besides the time it took to make up the solutions we ended up with variations from batch to batch. And in order to get the solution working right, we had to heat it up to 140° F and over.

"So we did the wise thing... stopped making our own and started to use HUNT S.C.E. which works at room temperature. Now we have no more chemical dangers. We are really saving money — etching time is standardized and we maintain a uniform production rate around the clock."

HUNT S.C.E. (Solder Circuit Etch) is superior to plant mixed etchants because it:

1. Etches rapidly at room temperature.
2. Is a ready, prepared product designed specifically for this one purpose.
3. Has a high capacity for copper.
4. Never attacks the solder plated circuit.
5. Has guaranteed uniformity and is the highest quality because of rigid laboratory control.
6. Gives fast, odorless etching of the copper.
7. Produces boards that pass all corrosion and stability tests.

Manufacturing Chemists — QUALITY CONTROLLED HUNT CHEMICALS — *Established 1909*

For detailed information about HUNT S.C.E. and valuable production handling information, write for Technical Bulletin No. 3 — *"The Etching of Solder Plated Circuit Boards by Hunt S.C.E. Solution."* Hunt S.C.E. Solution is available in 125 pound (12 gallon) carboys and 530 pound (55 gallon) drums.

PHILIP A. HUNT COMPANY

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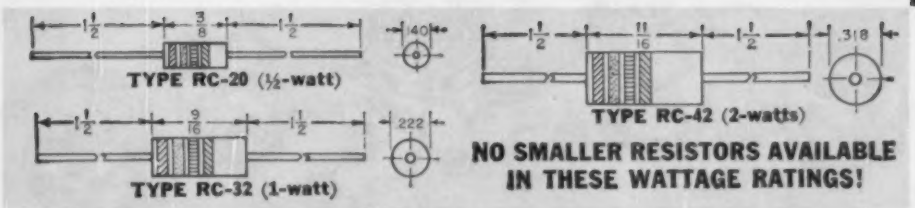


This is the kind of

PLUS PERFORMANCE

You get when you specify COLDITE 70+ resistors

This performance table for the RC-32 (short) 1-watt Coldite 70+ Resistors speaks for itself. Similar test data proving equally good performance for the RC-20 (½-watt) and RC-42 (2-watt) units will gladly be sent on request to: Electronic Components Division, Stackpole Carbon Company, St. Marys, Pennsylvania.

NO SOLDERING PROBLEMS! You'll get faster, better production—either manual or automatic—with Coldite 70+ than with any other resistors of their type! Hot tin dipping of leads assures real "solderability." What's more, the resistors can be supplied oriented and aligned on reel packs.

RESISTANCE-TEMPERATURE CHARACTERISTICS	Average Percent Resistance Change					
	10 ohms		270,000 ohms		22 megohms	
	COLDITE 70+	MIL-R-11B	COLDITE 70+	MIL-R-11B	COLDITE 70+	MIL-R-11B
@ −15° C	1.5	3.25	2.2	7.5	6.7	12.5
@ −55° C	3.7	6.5	6.2	15.0	15.7	25.0
@ +65° C	1.6	2.5	1.1	5.0	4.0	7.5
@ +105° C	2.1	5.0	5.7	10.0	3.7	15.0
VOLTAGE COEFFICIENT per volt	Not applicable		0.0068	0.0200	0.0160	0.0200
LOW-TEMPERATURE STORAGE	0.1	2.0	0.1	2.0	1.0	2.0
LOW-TEMPERATURE OPERATION	0.1	3.0	0.2	3.0	0.5	3.0
TEMPERATURE CYCLING	0.1	4.0	1.1	4.0	0.2	4.0
MOISTURE RESISTANCE	3.7	10.0	7.4	10.0	3.2	10.0
SHORT TIME OVERLOAD	0.2	2.5	0.13	2.5	0.2	2.5
LOAD LIFE at 70° C						
after 50 hours	0.2	6.0	3.0	6.0	0.25	6.0
after 250 hours	0.4	6.0	1.9	6.0	0.9	6.0
after 500 hours	0.5	6.0	1.9	6.0	1.9	6.0
after 1000 hours	0.5	6.0	1.5	6.0	2.3	6.0
LEAD TWIST TEST	0.04	1.0	0.0	1.0	0.1	1.0
EFFECT OF SOLDERING	0.2	3.0	0.6	3.0	0.4	3.0

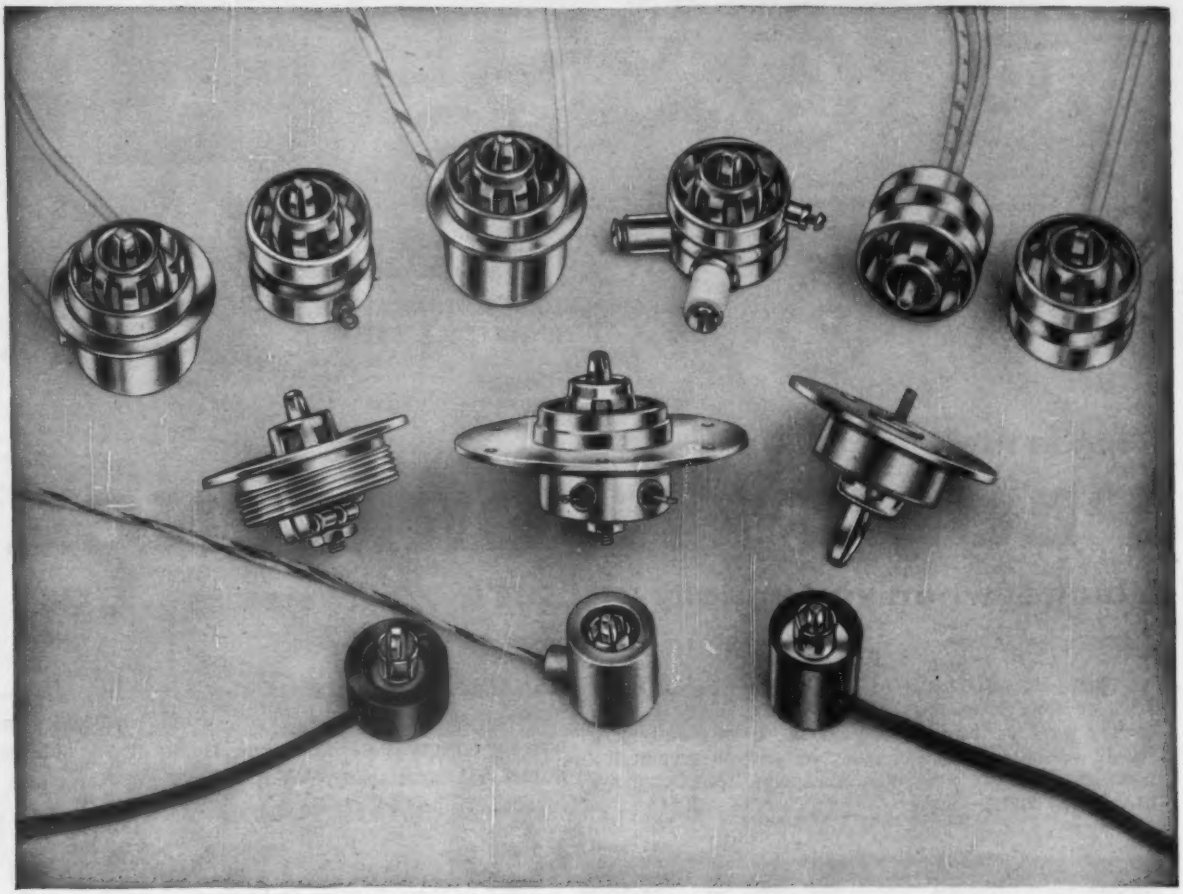
DIELECTRIC STRENGTH All Stackpole Type RC-32 Coldite 70+ Resistors withstand 1000 volts r.m.s. at atmospheric pressure for 5 seconds as well as 625 volts r.m.s. at 3.4 inches of mercury for 5 seconds without damage, arcing or breakdown.

TERMINAL SECURITY All Stackpole Coldite 70+ Resistors withstand the standard 5-pound pull test.

STACKPOLE
Coldite 70+®
fixed composition resistors

Setting the standards by which other resistors will be judged.

FIXED AND VARIABLE COMPOSITION RESISTORS • SNAP AND SLIDE SWITCHES • **CERAMAG**® FERROMAGNETIC CORES • FIXED COMPOSITION CAPACITORS • IRON CORES • **CERAMAGNET**® CERAMIC MAGNETS BRUSHES FOR ALL ROTATING ELECTRICAL EQUIPMENT • ELECTRICAL CONTACTS • AND HUNDREDS OF RELATED CARBON, GRAPHITE AND METAL POWDER PRODUCTS



Ucinite Magnetron Connectors

Ucinite manufactures a variety of special connectors for the heater and heater-cathode terminals of magnetrons. Many of these have been adapted for special applications as to size and function to meet the sealing and mounting requirements of high temperature and high altitude operation and other special conditions.

Connectors are coaxial in construction and can be supplied with built-in capacitors for added protection. Connecting leads of any length can be furnished to customer's specifications.

With an experienced staff of design engineers, plus complete facilities for volume production, Ucinite is capable of supplying practically any need for metal or metal-and-plastics assemblies. Call your nearest Ucinite or United-Carr representative for full information or write directly to us.

ELECTRICAL ASSEMBLIES Ucinite RADIO AND AUTOMOTIVE

The UCINITE CO.

Newtonville 60, Mass.

Division of United-Carr Fastener Corp.

Specialists in

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RADIO AND AUTOMOTIVE

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PACEMAKER LINE

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Direct Reading Frequency Meters

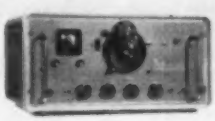
MOST COMPLETE LINE... FOR EVERY PURPOSE, EVERY BUDGET

HIGH PRECISION, DIRECT READING METERS (0.015%)

Series 555 to 579 consists of 30 different types covering from 0.925 to 39.0 KMC/S. Representing highest state of the art, these frequency meters fully qualify as transfer or secondary standards for exacting laboratory or production service. Features include: hermetically sealed invar cavity, temperature-compensation, high Q, optimum cavity geometry, high conductivity plating.

PRECISION HETERODYNE FREQUENCY METER (0.002%)

Type 504, for 100 to 10,000 MC/S with accuracy of 0.002% at crystal check points every 5 MC/S and 0.03% or better between check points. Automatic interpolation by unique patented spiral-scale dial. Beat indication by both external earphones and built-in CRT. Meter is self-contained and portable.



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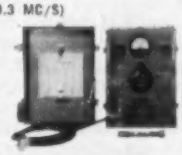

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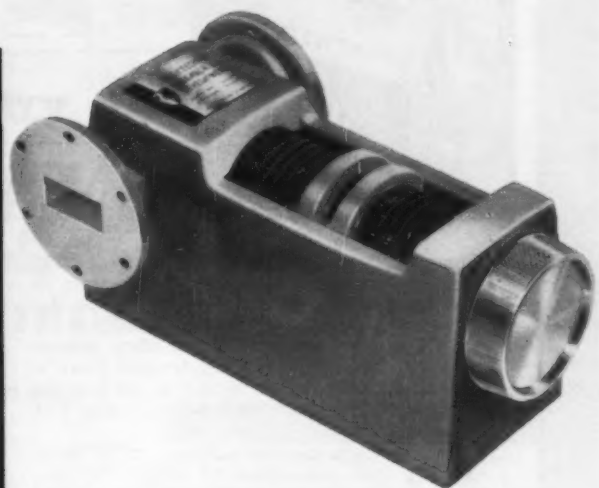

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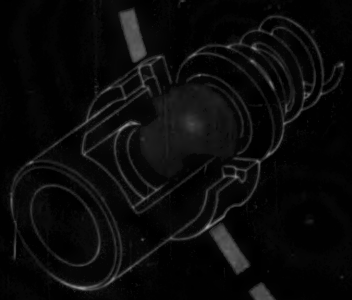

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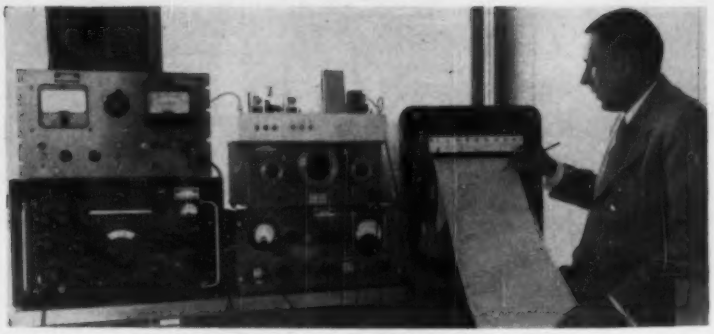


Satellite transit log being scanned shortly after Explorer I passage. Analysis of data yields information on orbital period and its rate of decrease

Keeping Track of Earth Satellites

Interferometer system consists of a dual-terminal array of 22 dipoles proximity coupled to a 2-wire line. Antenna works into a receiver which converts 108-mc satellite transmissions to a 1-kc signal. Recorder logs transit time within 1 second as satellite crosses antenna beam null

By C. J. SLETTEN, G. R. FORBES, Jr., and L. F. SHODIN,
Headquarters, Air Force Cambridge Research Center, Laurence G. Hanscom Field, Bedford, Mass.

A RADIO DIRECTION-FINDING antenna system using a 108-mc dual-terminal linear array obtains accurate single coordinate position data at one instant in each orbital cycle of an earth satellite. In conjunction with the antenna system, a specially designed receiver allows the antenna to be calibrated using the sun and radio stars as sources. Time-integrating circuits in the receiver make possible the detection of low levels of satellite signals. Meridian transit times to accuracies of about one second have been obtained from Explorer I and II and Vanguard with this system.

To make a dual-terminal linear-array system practical for cheap installation, a method for simple but accurate control of radiation is essential. This is achieved by using electric dipoles proximity coupled to a two-wire feeding transmission line. A matching balun connects the two-array terminals to coaxial lines.

In operation, the antenna array is located in the plane of the earth and oriented along a true east-west line. When the energy received at the two terminals of the antenna is combined in a hybrid network, a pattern with a broadside fan beam is obtained at one hybrid network output and simultaneously a pattern with a deep broadside null is obtained at the other.

The time at which the satellite transits the null in the broadside null

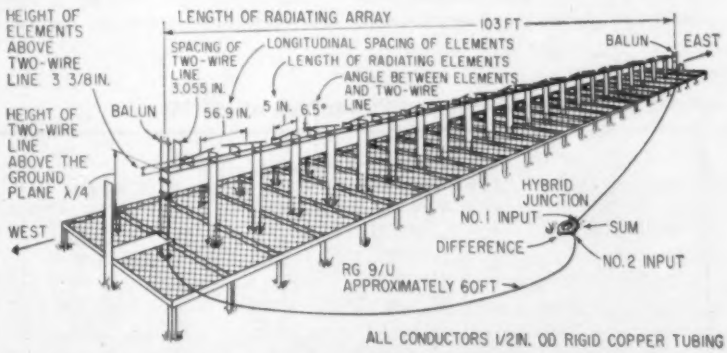


FIG. 1—Sketch of complete antenna assembly. Dimensions given are for a 22-dipole array at 108 mc. This configuration gives an antenna gain of 20 db over an isotropic radiator and a beamwidth of 5 deg calculated from the single terminal pattern

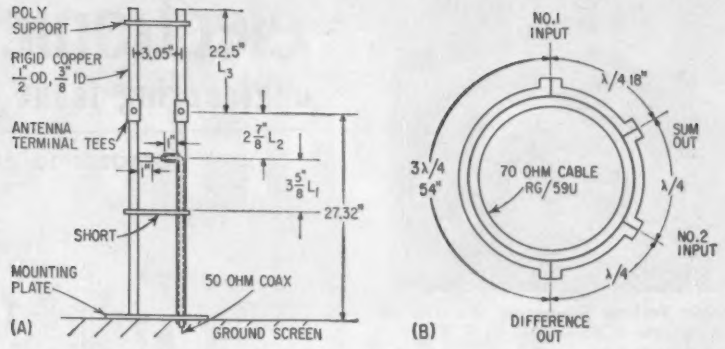


FIG. 2—Construction details of (A) matching balun and (B) coaxial hybrid junction

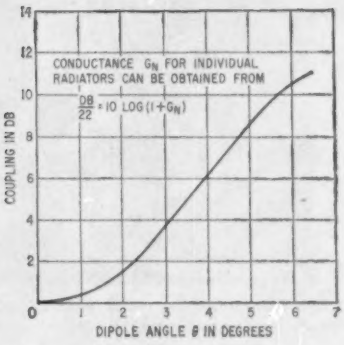

CONDUCTANCE G_N FOR INDIVIDUAL RADIATORS CAN BE OBTAINED FROM
$\frac{DB}{22} = 10 \log(1+G_N)$
COUPLING IN DB
DIPOLE ANGLE θ IN DEGREES

FIG. 3—Total array coupling

pattern gives an accurate single-coordinate fix. The broadside fan beam acts as a monitor during the detection time interval.

Balun Design

The balun, shown in Fig. 2, is designed for coupling coaxial cable to the two-wire line of the antenna. Unlike bazooka type baluns, the balance is independent of the matching parameters. The load of about 300 ohms is placed at a calculated point above the 50-ohm coaxial input and matching is achieved by adjusting the position of the shorting bar and open stub lengths. Two shorting bars keep all the energy off the coaxial line.

Line lengths L_1, L_2, and L_3 on the balun are readily found on a Smith chart and final adjustments made empirically. Actual dimensions for the balun and hybrid are shown for matching to one end of the 22-element 108-mc array when the other end is terminated in a matched load.

The incremental conductance of each element of the array and total array coupling are obtained from Fig. 3. The data were obtained by measuring the power drop through the array under single terminal transmitting conditions as the angle of the elements relative to the two-wire line was varied. The resonant length of the radiators was found in earlier experiments to vary little for the light couplings involved in such arrays. When all 22 of the radiating elements are set at 6.5 deg relative to the two-wire line a total of 90 percent of the applied power is coupled out. Heavier coupling can be obtained by reducing height of elements above the two-wire line. Coupling data for rotation less than 6.5 deg (Table I) are useful for building longer arrays.

Receiver System

The receiver system works on signals obtained by switching between the sum and difference terminals of the hybrid or between one of the outputs and a reference matched load. Switching is done at the rate of 100 cps by a mechanical chopper. This mode of operation makes it possible to detect signals below the ambient noise level of the receiver.

After amplification by a 108-mc converter and receiver, the output from the receiver phone jack is fed to a two-stage 100-cps filter V_1 and V_2, as shown in the schematic of Fig. 4. Before the signal reaches the filter, most of the high-frequency noise is removed by the R-C low-pass network consisting of resistor R_1 and capacitor C_1. Stage V_{1A} is a conventional amplifier whose output is fed through a parallel-T network tuned to 100 cps by variable resistors R_2, R_3 and R_4. Stage V_{1B} attenuates all frequencies except 100 cps and V_2 repeats the same process; however, gain control R_5 is inserted between V_1 and V_2 so that the receiver can be operated at a normal level without saturation. Tube V_3 is a cathode follower isolating the high impedance circuits of V_2.

Diode detector D_1 converts the 100-cps signal to d-c which is then integrated by resistor R_6 and paper capacitor C_2, selected for low leakage. This integrating network serves to smooth out interference and sudden transients.

Conversion of the d-c signal appearing across C_2 is accomplished by a balanced modulator consisting of stages V_4 and V_5. A 1-kc signal is taken from an audio oscillator and fed to the grid of V_6. This tube serves as a phase inverter and by adjusting the balance control R_7, two signals of equal amplitude but 180 deg out of phase appear on the plate and cathode of V_6. These signals are coupled to the grids of V_{4B} and V_{5B} and also appear across the two 1,000-ohm cathode resistors R_8 and R_9. If no voltage is present across capacitor C_3, V_{4A} and V_{5A} act as grounded-grid amplifiers. Since their plates are in parallel, the out-of-phase 1-kc signals cancel. How-

Table I—System VSWR and Power Loss at 108 Mc

Dipole Angle, Degrees	Input VSWR With Matched Load at One End	VSWR Looking Into Hybrid Ring Sum Arm	Total Radiated Power, Db
2	1.26	3.67	1.50
3	1.61	2.61	3.95
4	1.41	2.14	6.00
5	1.06	1.73	8.60
6	1.14	1.52	10.5
6.5	1.14	1.53	11.0

Cable loss is 2.3 db; loss in baluns and two wire line is 1.5 db

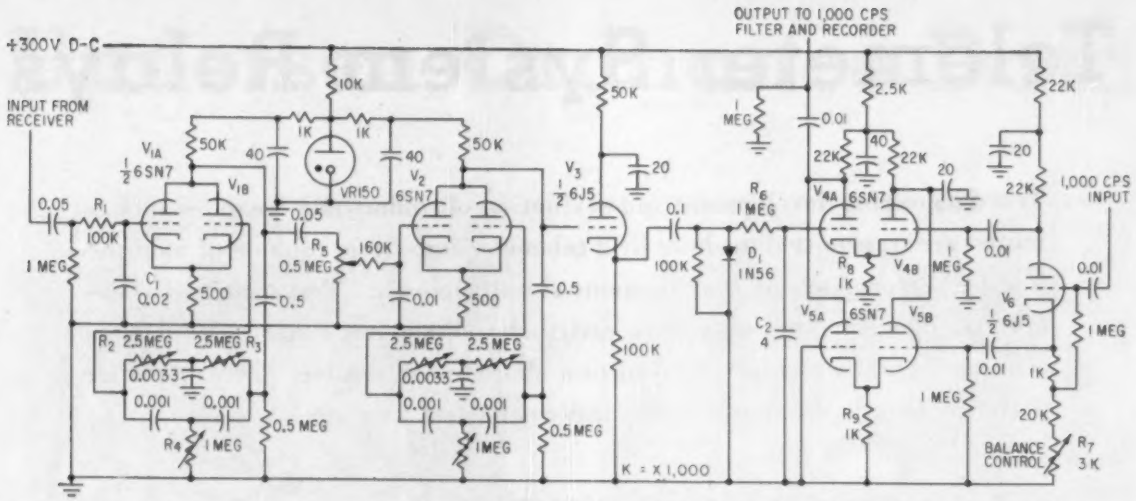


FIG. 4—Schematic diagram of auxiliary circuits. Input from receiver is a 108-mc signal chopped at a 100-cps rate. Use of filters and balanced modulator reduces noise and enables detection of low-level satellite transmissions

ever, harmonics are always present and a 1-kc filter must be used between the output terminal and the recorder for effective action of the balanced modulator. A bolometer-amplifier is employed as the 1-kc filter.

If a d-c component appears across C_2, the balance is upset and a 1-kc signal related in amplitude to the magnitude of the received signal appears at the recorder output terminal.

Calibration

For satellite tracking the location of the null plane must be known accurately. The sun, moon, and radio stars were all tried as calibrating sources. None of these sources proved to be wholly satisfactory. Sun signals fluctuate rapidly at 108 mc and average output varies widely from day to day making precise measurements difficult. Also, the sun is over 0.5-deg wide which is a poor approximation of a point source.

Most of the results reported here were achieved with the sun and satellites as sources because the weak output of radio stars was obscured by man-made noise in the Bedford, Massachusetts area.

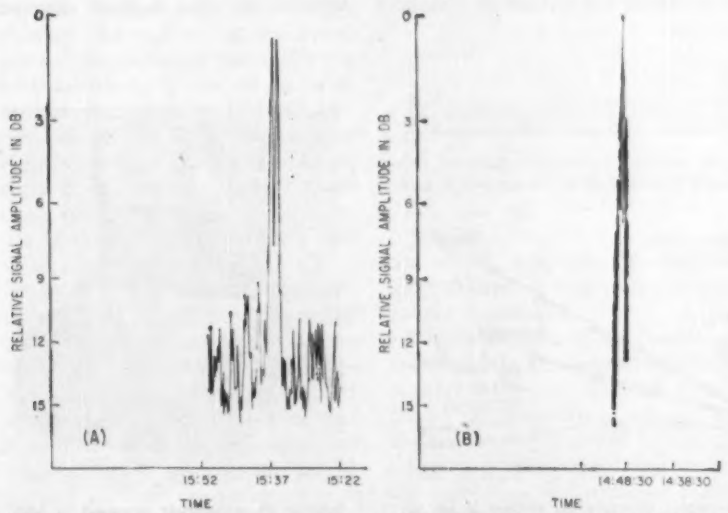


FIG. 5—Explorer I transit passage (A) recorded using difference output of hybrid junction. Sum minus difference connection (B) shows transit recorded as sharp pulse

After Explorer I was launched on January 31, 1958, strong signals were detected on the interferometer from the satellite's 108.035-mc and 107.995-mc transmitters. Three or four transits of our meridian (71 deg 16 min) were recorded each day.

Figure 5A shows a transit passage recorded using the difference (null) pattern. By watching the motion of the pen it is possible to estimate null crossing within one second of time. Unfortunately, the chart speed on the recorder was then too slow to show much detail about the Explorer's rapid signal variations with time. By analysis of these data, Smithsonian Astrophysical Laboratories were able to calculate the period of the orbit and estimate its rate of decrease.

When received on the sum minus difference connection, satellite signals produce a sharp signal as shown in Fig. 5B. Note that the signal from the satellite arises from a point source. There is a regular fading of the signal about every 10 seconds which is not exactly periodic but apparently always present. In addition to the regular 10 second fading more rapid variations are noticed when the signal is recorded without the 6-sec integrating time constant. These variations are deep fades occurring at 1-3 sec intervals. Slow variations in signal strength cause the two main lobes to be slightly unequal.

Telemeter System Relays

Test data during development and evaluation of underwater weapons such as mines, are transmitted to shore by a telemetering system capable of monitoring the performance of four weapons simultaneously. Transistorized transmitters, operating on separately assigned frequencies, convert the data to acoustic signals which are relayed to a shore-based receiver by cable after detection by a hydrophone in the underwater test area

By M. J. AUCREMANNE and D. D. WOOLSTON,
Underwater Evaluation Department, U. S. Naval Ordnance Laboratory, White Oak, Silver Spring, Md.

NAVAL UNDERWATER ordnance must be monitored during the development stage by methods that provide reliable test information. This article describes a transistorized underwater telemetering system, referred to as uts, that is capable of monitoring four underwater weapons simultaneously. Each weapon contains a transistorized transmitter with a separately assigned frequency band.

Data are converted by the transmitter from electrical to acoustical signals and projected into the water. The underwater signals are received by a hydrophone located in the test area and fed to the shore station by an underwater cable. At the receiver on shore, the signal is demodulated and recorded on a graphic recorder. These data are analyzed and the results are used in the development and evaluation of underwater ordnance.

Operation

The operation of the uts can be explained by referring to Fig. 1. Under field test conditions, underwater weapons such as mines are dropped from aircraft or planted by boats at the field test station. Usually the receiving hydrophone is placed in the area before the mines are planted, but the reverse procedure is possible. Normally, the four mines are located at distances of 200 to 600 ft from the receiving hydrophone.

As the target vessel approaches the mines, the mine firing mechanism senses the vessel and the telemetering transmitter is turned on. Subsequent mine information modulates the transmitter and is transmitted through the water as an f-m acoustical signal. This signal is detected by the receiving hydrophone and relayed by cable to the receiver on shore and recorded. When the mine no longer senses the vessel, the transmitter is turned off. This conserves the transmitter power supply by requiring maximum power only during transmission periods. A block diagram

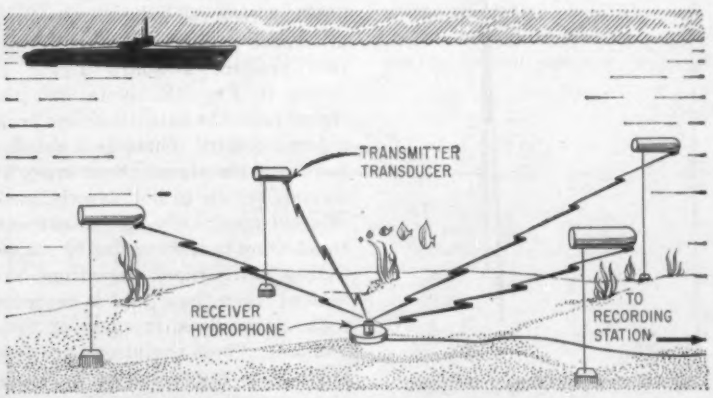
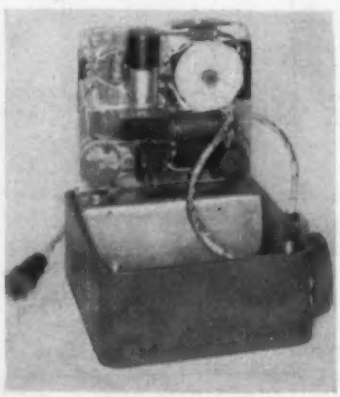
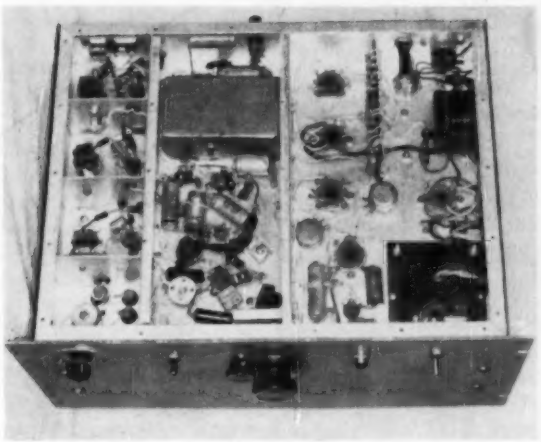


FIG. 1—Pictorial diagram illustrates how underwater telemetering system is set up to monitor performance of mines. The transmitters are activated by the mine firing mechanism, which senses the approach of the vessel at left

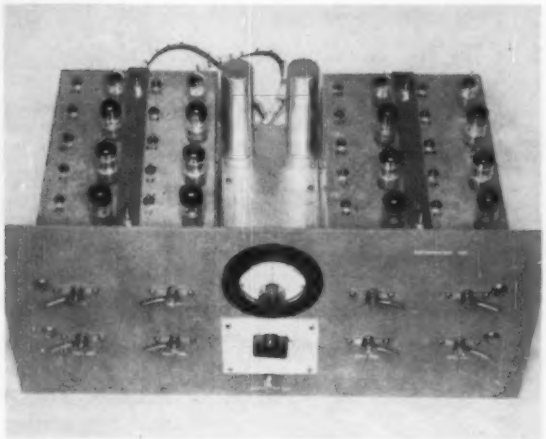


Interior of transmitter mounted in ordnance component. Unit withstands water-entry shock if dopped by aircraft

Undersea Ordnance Data



Bottom of uts receiver shows wiring layout. Note shielding techniques used in the amplifier and local oscillator sections



Four-channel discriminator is a compact, rack-mounted unit. It drives the direct-writing recorder which completes the system

of the telemetering system appears in Fig. 2.

Since mine operational data must be correlated in time with the position of the target vessel, the telemetering system is used in conjunction with field station tracking equipment. Thus mines are evaluated under operational conditions.

Transducers

The transducers are barium titanate types with the active element having a hemispherical shape. The operating region for the transducers is 50 to 65 kc with average sensitivities of 15 μv/μbar. Transducers having a bandwidth of approximately 20 kc are used as receiving hydrophones, while those used as projectors are selected on the basis of sensitivity for a particular frequency band.

The Q of the transducers is low, usually 2 to 4. A typical circle diagram of the transducer admittance is shown in Fig. 3. Since the telemetering transmitter must work efficiently, such a diagram is used in choosing the best operating region of each transducer. The frequency shift of the transmitter is small compared to the carrier frequency, consequently the region of the circle diagram showing the least change in the resistive component is selected.

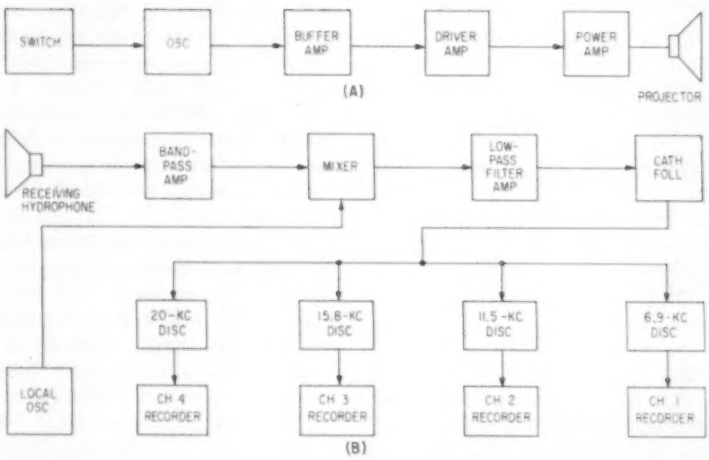


FIG. 2—Block diagram of complete underwater telemetering system. A major advantage of this system is its ability to provide ordnance data under operating conditions.

The impedance of the transducer appears as a series RLC circuit in parallel with the clamped capacitance. An equivalent circuit for the transducer is shown in Fig. 4A, where C_o is the clamped capacitance, C_m represents the motional capacitance, L_m represents the motional inductance and quantity R_m represents the motional resistance.

When the motional impedance branch is in series resonance, that is, when

$$\omega L_m - \frac{1}{\omega C_m} = 0 \text{ or if } \omega = \omega_m = \frac{1}{\sqrt{C_m L_m}}$$

the total admittance

$$Y_T = \frac{1}{R_m} + j\omega C_o$$

To make the transducer appear as a resistive load, an inductance L_o is

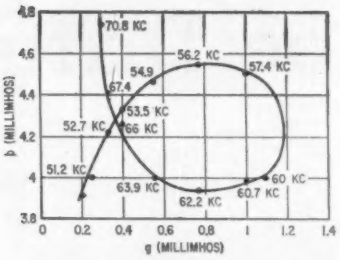


FIG. 3—Total admittance diagram for a typical barium titanate transducer

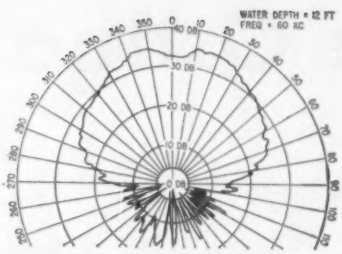


FIG. 5—Directivity pattern for a typical hemispherical transducer

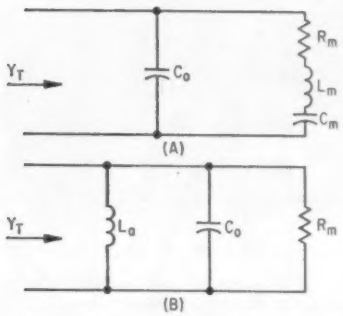


FIG. 4—Equivalent circuit diagrams of the transducer. Uncompensated case is shown in (A). In (B), L_a is added to tune out the clamped capacitance C_o

added in parallel across the transducer as shown in Fig. 4B. If

$$\omega C_o - \frac{1}{\omega L_a} = 0$$

and the Q of the coil is high, then

$$Y_T = \frac{1}{R_m} \quad \text{or} \quad Z_T = R_m$$

when $$\omega_m = \frac{1}{\sqrt{C_m L_m}}$$

This condition is possible only at one frequency. Since the frequencies representing ordnance information are less than 600 cps apart, the impedance seen by the transmitter power amplifier remains nearly constant.

The directivity patterns of the transducer, as shown in Fig. 5, are made to determine compatibility between the transducers and the hydrophone, to provide complete underwater acoustic coverage.

Transmitter

The transistorized transmitter weighs 3 lbs and is housed in a container 2-1/16 in. by 6 in. by 4-7/16 in. The transmitter consists of an oscillator, buffer stage, driver stage and a power amplifier that drives the barium titanate projector. The transmitter in each of the four mines being monitored is assigned a bandwidth of 1 kc in the 60-kc region. Of this 1-kc band, generally only 500 to 600 cps is used to monitor mine operation. The remaining portion of each band allows for temperature drift and power-supply effects. A schematic diagram of the transmitter is shown in Fig. 6.

The oscillator Q_1 is a temperature-compensated Clapp circuit. Additional temperature compensation may be obtained using a thermistor in the base circuit. The underwater ordnance mechanism modulates the transmitter by varying the current through saturable reactor T_1 in the tank circuit of the oscillator.

The buffer stage Q_2 is used for isolation and impedance matching between the oscillator and driver stages. This stage has a voltage gain of 0.95. Driver stage Q_3 is a grounded-emitter circuit. It has a voltage gain of 26 db when its output transformer circuit is tuned.

The power amplifier Q_4 is operated class C with an efficiency of approximately 70 percent. The 470-ohm resistor R_1 shunted by 0.15-μf capacitor C_1 provides the bias for this stage.

A powdered molybdenum permalloy toroidal core is used in the output transformer T_2 in the emitter circuit. The secondary of this transformer is tuned by capacitor C_2. The power amplifier has a gain of 25 db, using a 24-v d-c supply, and an output power of 1.2 w.

The impedance of the projector appears as approximately a 1,000-ohm resistive load with the clamped capacitance tuned out.

Switching Circuit

An *npn* silicon transistor Q_5 has its base and emitter in series with the underwater ordnance. When the ordnance is in a quiescent state, the transmitter is cut off and is turned on when the ordnance becomes active. The transmitter then transmits a specific frequency indicative of the type of response of the ordnance. The quiescent transmitter power dissipation is less than 25 mw as compared to 1.2 w when a signal is being transmitted. Capacitor C_3 in parallel with the base-to-emitter circuit protects the switching transistor from the initial surge current.

Receiving System

The receiving hydrophone was selected from among the available transducers on the basis of bandwidth. It has a bandwidth of approximately 20 kc to accept in-

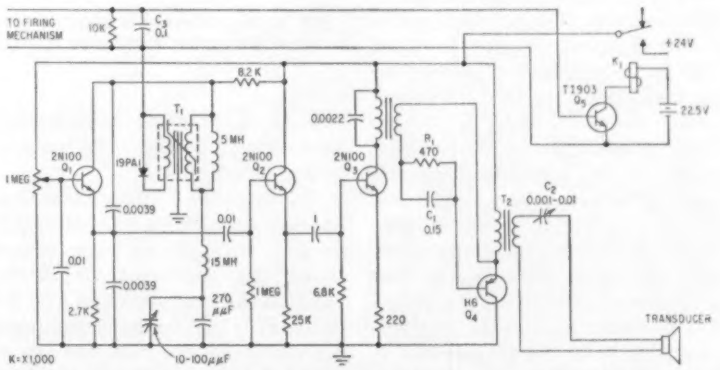


FIG. 6—Schematic diagram of the transistorized transmitter. When the mine senses the approach of a target, relay K_1 is activated, turning on the transmitter

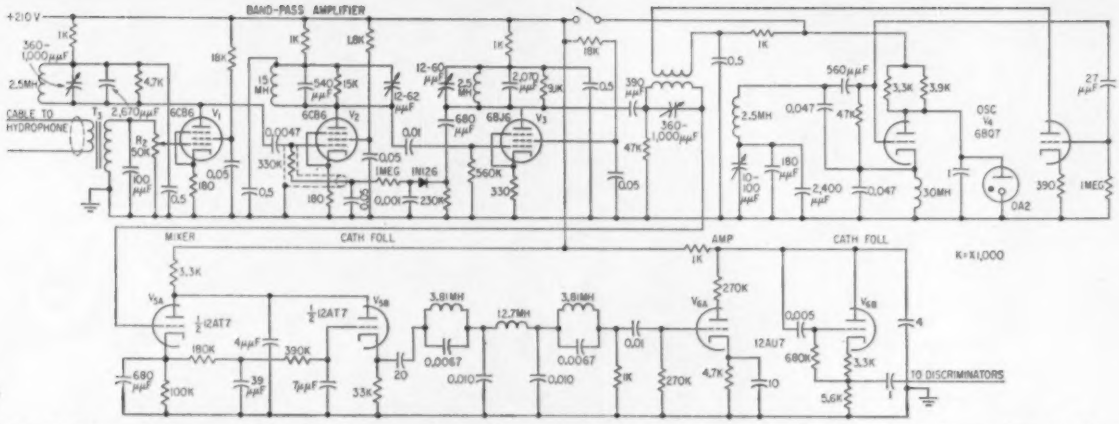


FIG. 7—Schematic diagram of the shore-based receiver. This equipment can receive and amplify four signal frequencies at a level as low as 1μv. The output of cathode follower V_{8B} is connected to four Foster-Seeley type discriminators (not shown) which demodulate the four data signals and drive a direct-writing recorder

telligence from the four underwater mine transmitters. In many field installations, the receiving hydrophone may be located 15,000 ft from the shore station. This might ordinarily present problems in the transmission of information at these frequencies; however, the underwater cables used at the field stations have an attenuation of only 6 db/10,000 ft. The characteristic impedance of the cable is 120 ohms. By using matching transformers to properly terminate the cable, minimum attenuation is obtained.

The telemetering receiver shown in Fig. 7 is composed of a band-pass amplifier, a local oscillator, a mixer stage followed by a low-pass amplifier and a cathode follower. In the present system, four signal frequencies from the mine transmitters are received and amplified in the bandpass amplifier. Since the amplifier passes all frequencies between 50 and 67 kc, the intelligence from the mines is accepted and all underwater signals or noise above and below the bandpass will be rejected.

Band-Pass Amplifier

The band-pass amplifier consists of V_1, V_2 and V_3 in a staggered triple having a gain of approximately 60 db and capable of utilizing signals as low as 1μv. Potentiometer R_2 allows the level of the incoming signals to be adjusted. Input transformer T_1 has an untuned-primary tuned-secondary which improves the spurious-signal rejection of the system. The signals from the mine transmitters are approximately of the same power and hence there is no blanking of one signal by any other. An age circuit adjusts the bias on V_1 to control the overall gain of the amplifier. Agc action prevents distortion from overloading of the receiver and provides proper signal voltages to the discriminators.

Oscillator

A local oscillator V_4 in a Clapp circuit is used instead of a crystal oscillator because the Clapp circuit allows the local oscillator frequency to be changed by several kc. This gives more versatility to the receiver and still provides frequency stability.

The local oscillator signal and the incoming mine data are fed into the mixer V_{5A}. Since only the difference frequencies are accepted by the discriminator, the sum frequencies are eliminated or greatly attenuated by placing a low-pass filter after the mixer.

The output filter network is composed of one symmetrical pi-type intermediate section having a half-section m-derived filter at each end. All sections in the filter are matched on an image impedance basis. Cathode follower V_{6B}, having a resistive output impedance of 1,000 ohms feeds the mixer output to the low-pass filter. The m-derived terminal half-section of the filter works into a 1,000-ohm resistive load.

The low-pass filter passes all the difference frequencies but attenuates all frequencies at 27 kc or above by at least 40 db. A high-gain amplifier V_{6A} and a cathode follower V_{6B} complete the receiver. The amplified difference frequencies are fed into the discriminators.

Discriminators

The discriminators are of the Foster-Seeley type designed so that each accepts informaton only from one telemetering transmitter; therefore, each discriminator translates the intelligence from its associated transmitter into d-c which in turn operates a direct-writing recorder. Correlation between mine actuation and target ship position is provided by the timing marks on the record.

Performance

Field tests demonstrate that the underwater telemetering system can telemeter ordnance information from an underwater weapon to a shore station. The transmitter can remain operative for at least six months, has survived water impact when dropped from an aircraft and is temperature-compensated over the range from 28 F to 90 F. It is small in size and weight, is contained in a water-tight case and can be made an integral part of the ordnance assembly.

The authors express their appreciation to M. N. Miraldi and R. J. Smollett for development assistance, J. V. Saliga for construction and packaging and R. S. Flum for providing the transducers.

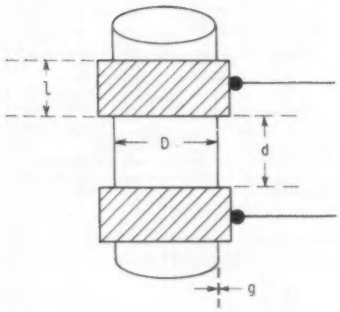


FIG. 1—Cell-tube capacitor. Sizes of various dimensions are: *D*, adjustable between 15 and 17 mm; *d*, adjustable between 5 and 36 mm; *l*, 20 mm and *g*, 0.4 to 0.5 mm

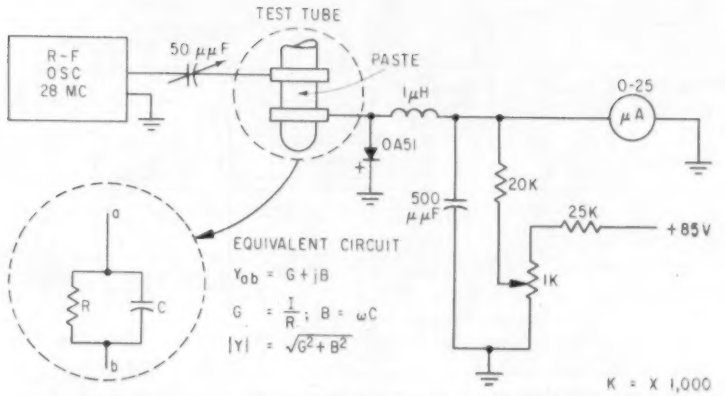


FIG. 2—Block diagram of setup for determining setting time of cement. Equivalent circuit of cell-tube capacitor is shown in dashed circle

Sample of cement is inserted as dielectric material in a test-tube capacitor and admittance readings made every 15 minutes. Maximum admittance signifies end of setting process. Comparison with mechanical test procedure proves that admittance technique is just as accurate and less complex

Electronics Determines

By J. M. TOBIO, Lab. de Ensayos Fisicos,
Instituto Tecnico de la Construccion y del Cemento, Costillares, Madrid, Spain

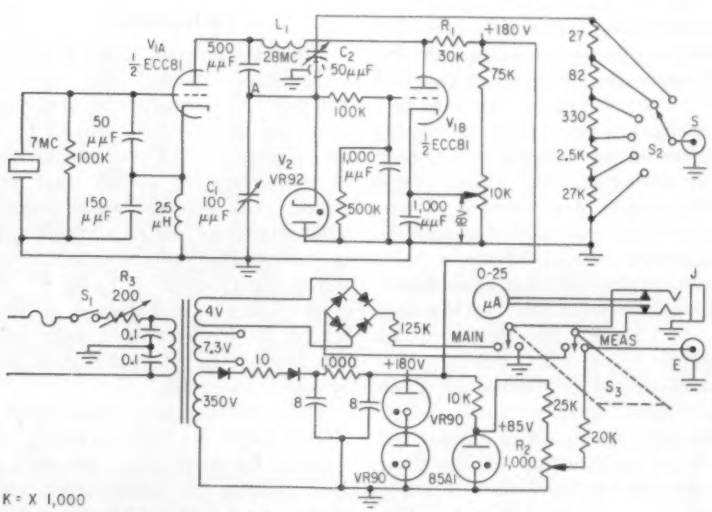


FIG. 3—Schematic diagram of the oscillator portion of the equipment

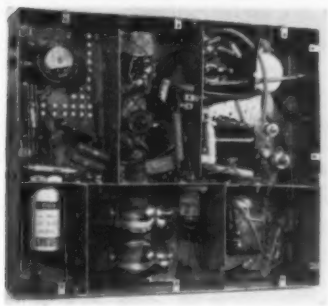
APPLICATION of dielectric techniques to the problem of determining the setting time of cement is not a new concept.[1, 2, 3] The system to be described, although basically similar in approach to the measurement is much less complex.

In its simplest version, the measurement consists of determining the variations in admittance of a cement paste during the process of setting. Once the paste is mixed, it is placed in a cylindrical capacitor where it functions as the dielectric material. The capacitor consists of two coaxial copper rings encircling a test tube as shown in Fig. 1.

Measurement fundamentals are indicated in the block diagram of Fig. 2. A stabilized 28-mc oscillator

Simplicity of the test equipment is shown in this in-use illustration

Mechanical comparison test requires use of this apparatus



Internal construction of r-f oscillator portion of equipment

Cement Setting Time

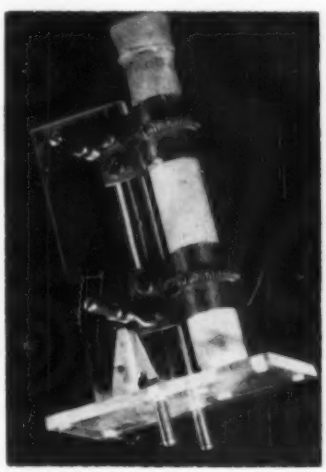
supplies a signal to the top plate of the capacitor cell. Resulting current, rectified by a germanium diode, is measured with a microammeter. Meter readings are proportional to the absolute value of the admittance obtained from the equivalent circuit also shown in Fig. 2.

Oscillator

Circuit of the oscillator is shown in Fig. 3. It is a harmonic oscillator modified from a constant-amplitude oscillator developed at the National Bureau of Standards.[4] In Fig. 3, V_{1A} functions as a crystal oscillator at 7 mc. The anode circuit containing L_1 and C_1 is tuned to 28 mc.

The r-f potential existing at point A, Fig. 3, is fed through an adjustable capacitor C_3 to an output attenuator. This same potential is rectified by V_2 and applied to the control grid of V_{1B}, which operates as a regulator.

Initial negative bias on the cathode of V_{1B} is about 18 v. This amplitude is sufficient to hold the tube cut off. When the rectified output of V_2 is applied as positive voltage to the control grid of V_{1B}, it causes conduction. When, for any reason, the potential at point A drops, V_2 rectifies less and the control-grid voltage of V_{1B} becomes less positive. As a result, the triode draws less current; the drop in voltage across R_1 is less; the plate of V_{1A} becomes more positive and oscillation increases in amplitude.



Test capacitor has this configuration

Final Stabilization

When r-f potential at point A increases, the process is reversed. After a few trials and adjustments, the potential at point A can be made independent of both supply fluctuations and load across the attenuator.

The microammeter shown in Fig.

3 has a double purpose. It serves both as a main voltage control and also provides a reading of admittance values. Jack J disconnects the microammeter and connects an external recording device, if desired.

To emphasize admittance variations, an opposite voltage is applied to the measuring circuit[5]. This voltage is stabilized with the 85A1 tube and is adjusted by potentiometer R_5.

Equipment Operation

Once the instrument is turned on by switch S_1, Fig. 3, switch S_3 is placed in the MAIN position. Next, R_3 is adjusted so that a predetermined reading is obtained on the meter. This reading serves as a reference for all measurements.

After the test progresses for about three or four minutes, S_3 is changed to MEASUREMENT and the resulting value is read on the meter. Simultaneous use of attenuator S_2 and potentiometer R_3 accomplishes required calibration of the instrument. The meter should read at about its center-scale point.

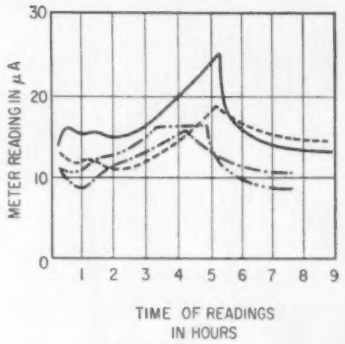


FIG. 4—Typical admittance curves for several Portland cements

For a cement of average setting, a measurement should be made every 15 minutes. If use is made of recording equipment, the apparatus should be kept on continuously. Relative admittance values should be plotted against time.

Curves of admittance against time such as shown in Fig. 4 are then obtained. The maximum points of these curves correspond to the end of the setting process for various Portland cements.

Experimental Checking

In earlier experimental work[2, 3], a close correlation between setting times obtained from admittance curves and those resulting from use of the Vicat needle method was observed. To carry out a more precise check, a provisional experimental arrangement was prepared as shown in Fig. 5.

A steel-toothed wheel 26.5 mm in diameter is driven by an eight-rpm motor. The wheel is mounted on a sliding frame driven at a constant linear velocity of 13 mm per hour by a synchronous motor. The combined rotational and linear motions of the wheel cut a groove in the concrete test specimen of 1 to 3 mm in depth. The specimen is attached firmly to the framework of the apparatus.

To determine mechanical resistance of the paste—to measure the work required to cut the groove—the amount of current drawn by the eight-rpm motor is recorded by a ballistic galvanometer and a photographic device.

Test Results

If a simultaneous test is made with the mechanical apparatus and the admittance recorder, the graphs shown in Fig. 6 are obtained for the same cement. Curve A corresponds to the admittance measurements and curve B to the mechanical system. Note how point P of curve A (end of setting) corresponds to the sudden increase CD in curve B caused by a rapid increase in mechanical strength.

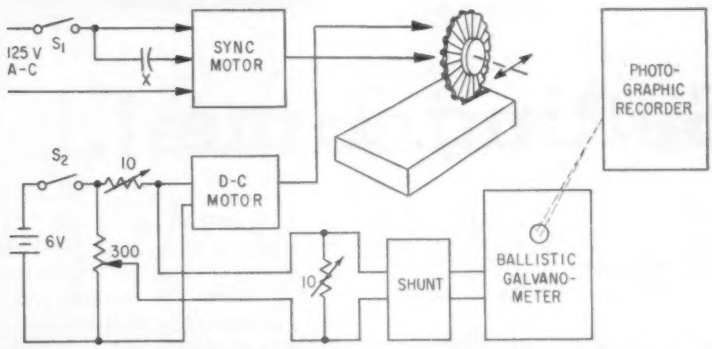


FIG. 5—Mechanical system used for comparison experiment. Work required to cut groove in cement is indicated by d-c motor current

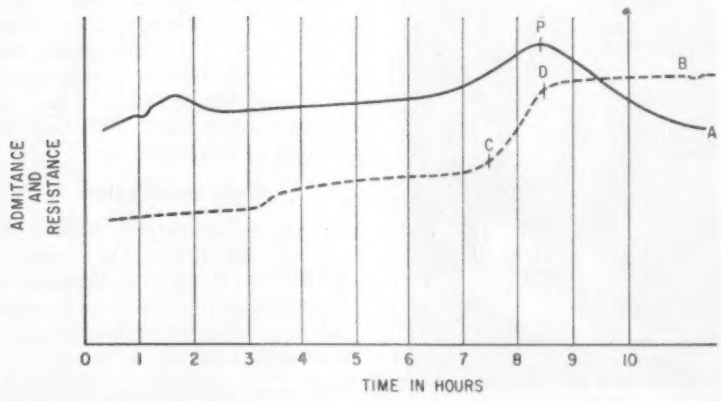


FIG. 6—Comparison of curves for admittance (A) and mechanical-resistance (B) methods of determining cement setting time

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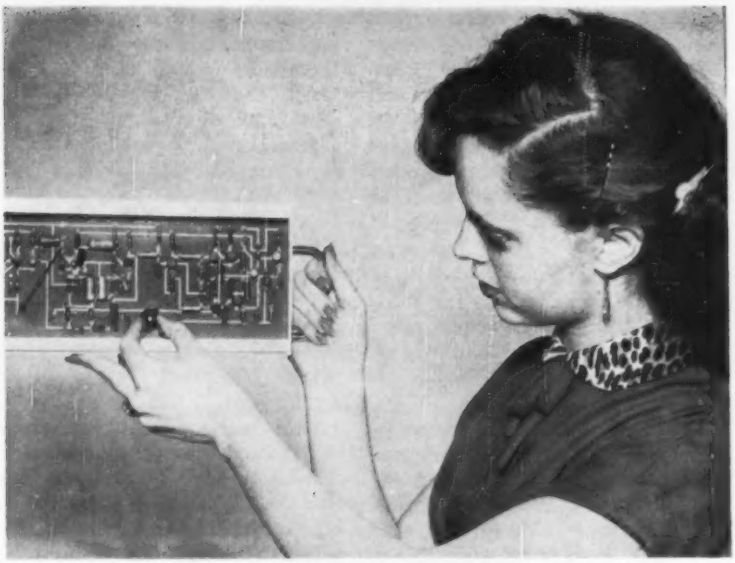
(4) N. C. Hekimian, *Radio-Electric Eng.* p 36, Feb. 1954.

(5) G. G. Blake, "Conductimetric Analysis at Radio Frequency," Chapman and Hall, London, 1950.



Operator adjusts clipping level on read amplifier. Signal-to-noise ratio of three to one will give reliable operation in digital data system

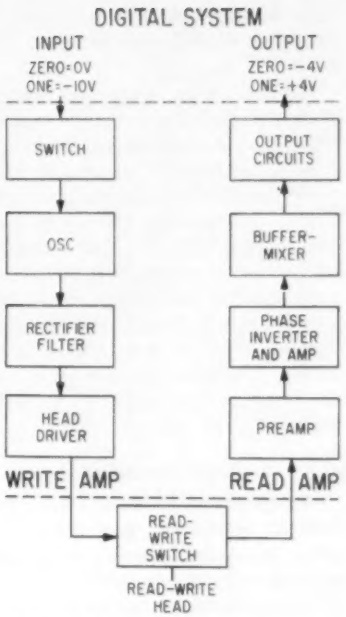


FIG. 1—Digital tape system

Universal Tape Amplifiers for Digital Data Systems

Transistorized read and write amplifiers have wide-range input characteristics which accommodate most digital tape systems. Both return-to-zero and nonreturn-to-zero pulsing techniques can be used at repetition rates up to 22 kc. Adjustable clipping circuit in read amplifier permits insertion of 0 to 2.5 mv input noise discrimination

By **ROBERT F. SHAW,** Digitronics Corp., Albertson, New York

MAGNETIC TAPE record and playback amplifiers used in sound reproduction equipment do not have all the characteristics needed for processing digital data. To fill this void, the read and write amplifiers discussed here have been designed specifically to meet requirements of most digital tape handling systems.

A block diagram of a read-write system is shown in Fig. 1. The read and write amplifiers are intended to be used with relay-type read-write switching. Although electronic switching is more desirable, few magnetic tape applications justify the extra cost involved.

During read operation, signals from the read-write head are applied through the read amplifier to logic circuits in the digital system. Functionally, the read amplifier consists of four sections: a preamplifier to provide necessary initial signal gain; a phase inverter and amplifier circuit to separate and amplify negative and positive signals; a buffer-mixer to pass positive signals for rz (return-to-zero) operation or to combine positive and negative signals for nrz (nonreturn-to-zero) operation; and an

output to provide sufficient current to drive digital system logic circuits.

During write operation, signals from the digital system are applied through the write amplifier to the read-write head. Functionally, the write amplifier consists of four sections: a transistor switch to control application of input voltage; an oscillator to generate a carrier frequency; a rectifier-filter to convert carrier to d-c and discriminate against residual a-c; and a head driver to amplify the recorded signal by an amount sufficient to drive the read-write head.

Read Amplifier

A tape read amplifier must deliver an output swing of −4 to +4 volts to satisfactorily drive the logic circuits of transistorized digital data handling equipment. Commonly available digital read heads provide an input signal of approximately 6 millivolts peak-to-peak from tapes magnetized to saturation during recording of ones and zeros and played back at the usual 60 to 75 ips speeds.

In practice, reliability is assured by designing the amplifier to perform satisfactorily with appreciably weaker input signals and to handle stronger signals without overloading. The amplifier shown in Fig. 2 gives full output with inputs as low as 1.35 millivolts zero-to-peak and will not overload with inputs up to 5 millivolts zero-to-peak. Good discrimination is obtained by using an input threshold of 0.4 millivolts, below which no output is produced.

Tests show the amplifier gives satisfactory reading at pulse repetition rates up to 22 kc. Major limitation on repetition rate is the high inductance of the head in use. A lower inductance head will allow operation at repetition rates up to 30 kc.

Preamplifier

Signal level requirements indicate that overall gain of the read amplifier must be about 10,000 after allowances have been made for noise clipping and overdrive of high level stages. To obtain this gain with good stability, a feedback-stabilized preamplifier is used. This circuit amplifies the signal until a point is reached where further stabilization can be accomplished by simple emitter degeneration and clamping circuits. Feedback of 60 db is introduced to give a voltage gain of 1,000 within ±10 percent even when gain of individual stages varies as much as ±25 percent.

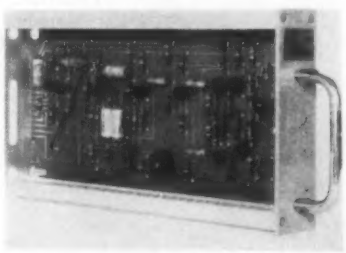
Transistor Q_1 is connected as an emitter follower and is used to drive the emitter of mixer Q_2. The feedback line from the last amplification stage is connected to the base of Q_2 and is loaded by a 1,000-ohm resistor.

Following the mixer is a conventional two-stage amplifier employing capacitively coupled grounded-emitter stages. Bias stabilization is used to compensate for temperature changes up to 125 F.

Low-frequency response of the amplifier is down 3 db at 200 cps. Since the other coupling circuits have a much lower cutoff frequency, this characteristic is primarily determined by the coupling network made up of C_1 and the input resistance of Q_3. High-frequency response of 3 db down at 65 kc is primarily determined by capacitor C_2 and the input impedance of Q_4.

Phase Inverter and Amplifier

Usefulness of a tape reading amplifier is increased if the same unit can be used for reading either rz or nrz recordings. This facility is provided in the read amplifier through use of a phase inverter and optional buffer-mixer circuit for mixing positive and negative signals.



Read amplifier shown on plug-in package with covers removed

A conventional phase inverter circuit is used. Transistor Q_5 applies both positive and negative going pulses to two grounded-emitter amplifier stages made up of transistors Q_6 and Q_7. One amplifier stage is used for each polarity. These stages have a gain of two and are stabilized by use of precision resistors and degeneration.

Buffer-Mixer

Outputs from amplifiers Q_6 and Q_7 drive emitter followers Q_8 and Q_9, respectively, in the buffer-mixer. Diodes D_1 and D_2 associated with Q_8 and Q_9 serve to isolate the output circuits from the rest of the preamplifier.

If it is required to operate in the rz mode, the output of Q_8 is coupled through D_3 to Q_{10} permitting the use of only one loop of the tape signal. If nrz operation is required, the outputs of Q_8 and Q_9 are connected together applying an output signal to Q_{10} whenever a flux change in either direction is sensed by the read head.

Noise clipping is accomplished by biasing buffer diodes D_3 and D_4. Clipping level is controlled by manually adjusting potentiometer R_1 to change the base voltage level of Q_8 and Q_9. Although up to 5 volts of clipping is possible with circuit parameters shown in Fig. 2, under normal circumstances the level is set to about 0.8 volt. This level actually corresponds to 0.4 millivolt of noise since the preamplifier has a gain of 1,000 and the amplifier stages have an overall gain of 2.

Output Circuits

A driving signal totaling 2.75 volts is required at the emitter of Q_8 or Q_9 to produce output with a 1.35-millivolt input signal. Magnitude of the driving signal is determined by five voltage requirements: 0.25 volt to drive current through diodes D_1 and D_2; 0.2 volt to cut off Q_{10}; 0.6 volt to compensate for variations imposed by emitter supply impedance of Q_{10}; 0.8 volt necessary to overcome clipping threshold as discussed previously; and 0.9 volt which must be allowed for gain variations and level shifts resulting from supply voltage and impedance variations.

Emitter supply voltage of Q_{10} and its collector clamping voltage are −4 and +4 volts, respectively; therefore, these voltages represent

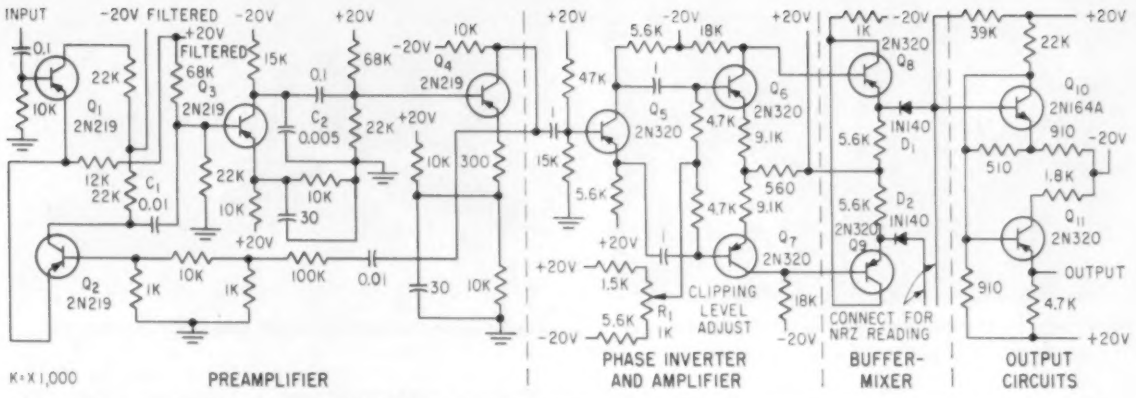


FIG. 2—Read amplifier circuit presents 10,000-ohm input impedance to read head. No-signal input produces a −4 volt output; peak input produces a +4 volt output

the end points of the output voltage swing. An output current of 8 ma at the positive end of the swing is provided by emitter follower Q_{11}.

Output waveforms are clean square waves for rz operation. For nrz operation, there are variations in the d-c operating points of Q_6 and Q_7 which result in slight width variation between the output pulses derived from positive and negative going signal loops. This difficulty could be avoided by phase inverting at a higher amplitude level; however, such a circuit involves a more complex coupling arrangement since a simple phase inverter cannot handle greater signal swing without distortion at the existing supply voltages.

A write amplifier must provide enough driving current through the write head to saturate the tape in either direction. Since most digital systems do not use a separate erase head, failure to saturate results in incomplete erasure of previous data. Desired magnetizing current must be produced in response to a signal at the amplifier input comparable with that produced by average digital logic circuits. In the write amplifier design described here, a negative signal having a 10-volt amplitude with respect to ground is required across the 10,000-ohm input resistance to give sufficient output current.

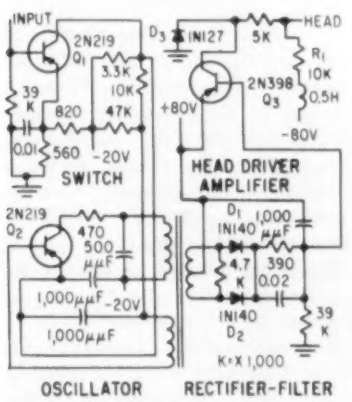


FIG. 3—Write amplifier circuit delivers a ± 8 ma swing to record head. Rise time in sec equals 0.04 times product of head inductance in mh and zero-to-peak current in ma

Write Amplifier Design

This amplifier has been designed to produce an output swing of ±8 ma which is the tape saturation current required for a typical digital recording head. In addition to saturating the tape, the output current through the head must have a rise time sufficient to record at the 10-kc to 20-kc rates currently used for digital data recording. Rise time is 15 millisec using a head with 50-millihenry inductance, but this can be brought down to 10 millisec with the same circuit using a lower impedance head. Higher impedance heads give correspondingly longer rise time.

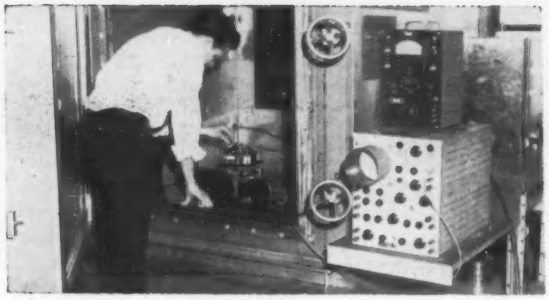
Since the write amplifier is used for nrz recording, direct coupling is used. This arrangement presents the usual stability and level problems associated with d-c amplifiers. These problems are solved using the carrier-type amplifier circuit shown in Fig. 3.

When turned on by a negative 10-volt input signal, switching transistor Q_1 applies voltage to the oscillator circuit consisting of Q_2 and associated parts. A frequency of approximately 300 kc is generated by the oscillator and fed by way of a centertapped winding on the oscillator transformer to a full-wave rectifier made up of diodes D_1 and D_2 and a simple R-C filter network. The rectified signal is then delivered to output amplifier Q_3, but only while a negative input voltage remains on the base of Q_1.

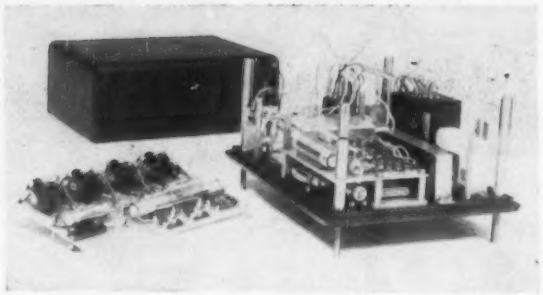
High-voltage transistor Q_3 is used to drive the head circuit. In the absence of an output signal, Q_3 conducts and its 16-ma collector current is divided equally between the head and R_1. Application of an input signal causes the rectified oscillator output to bias Q_3 cutting it off and permitting an 8-ma current flow through the head and R_1 in a direction opposite to that produced with no signal. Diode D_3 protects Q_3 against overvoltage whenever the head is disconnected.

Appropriate change of output resistors permits higher current without a corresponding change in the output driver; however, rise times will be increased unless lower inductance heads are used. Output current can be maintained indefinitely in either direction through the head without overload.

The author acknowledges the help of Robert MacKenzie, E. Wolf and Milton Schwartz in developing of these amplifiers, and of Eugene Leonard who was responsible for the general direction of the program.



Discriminator is balanced before test run in altitude chamber



Closeup shows discriminator (right) and servo amplifier (left)

By **ROGER HILL**, Development Engineer, Avionic Division, John Oster Mfg. Co., Racine, Wisconsin

Discriminator Controls

Servo discriminator measures phase with respect to preadjusted components and thereby makes accuracy a function of initial setting. At 400 cps, circuit has 100-millivolt d-c output for a frequency deviation of ±1/2 cps. Absolute accuracy remains ±0.125 percent between −55 and +100 C ambient

AIRCRAFT ALTERNATORS with tight frequency tolerances are often driven through a constant-speed transmission that is part of a feedback control loop with an error sensing device and a servo drive.

The inexpensive discriminator to be described is a fast-acting substitute for a standard error detector. With an input of 400 cps it has 100 millivolts d-c output at as high a power level as practical for a frequency deviation of ±1/2 cps. Absolute accuracy remains within ±1/2 cps in an ambient temperature range of −55 to +100 C. The output of the discriminator is fed into a silicon-diode modulator. The 100 millivolt figure is arbitrarily chosen to give an adequate signal to noise ratio at the output of the modulator.

Basic Circuit

The output E_{oo} in Fig. 1 is a function of the difference between the changes in E_{o1} and E_{o2}. The change in E_{o1} due to a change in frequency is a function of quantity T_1. A value of $T_1 = R_1C_1$ equal to $1/\sqrt{2}\omega$ results in maximum sensitivity for the upper portion of the discriminator; while the lower half has its greatest sensitivity when $T_2 = R_2C_2$ equals $\sqrt{2}/\omega$.

For a 100-millivolt output during a half-cycle deviation from 400 cps with $C_F = 0$, E_{11} and E_{12} must equal 116 volts rms. Now, if C_F is increased until peak rectifier action is approached, the 100-millivolt output is raised to approximately 150 millivolts. With a load R_L equal to twice the source impedance of the discriminator the output drops back to 100 millivolts. When R_S is neglected and the source impedance of E_{11} and E_{12} is considered negligible with respect to $1/\omega C_1$ and R_2 respectively, then the source impedance of E_{o1}, Z_{o1}, equals $R_1/(1 + j\omega R_1C_1)$ and Z_{oo} is $R_2/(1 + j\omega R_2C_2)$. With values for T_1 and T_2 substituted the absolute values of Z_{o1} and Z_{oo} at 400 cps are $R_1/\sqrt{1.5}$ and $R_2/\sqrt{3}$.

Lower values of R_1 and R_2 increase output power. However, input power requirements rise proportionately, as does the power that must be dissipated by R_1 and R_2. Furthermore, as the resistor values are reduced, the capacitor must increase.

With $R_1 = 4{,}260$ ohms, $R_2 = 8{,}520$ ohms and $C_1 = C_2 = 0.066$ μf, each resistor dissipates only one watt. Because of the low-power dissipation the temperature of each resistor rises little above ambient. Absolute values of respective source impedance Z_{o1} and Z_{oo} are 3,480 ohms and 4,910 ohms.

Since the source impedance of the discriminator with $C_F = 0$ is the sum of the absolute values, it totals 8,390 ohms. Capacitor C_F raises the output voltage by a factor of 1.5 without providing any additional power. Consequently, the discriminator output impedance, raised by a factor of $(1.5)^2$, equals 19,000 ohms. Therefore, the re-

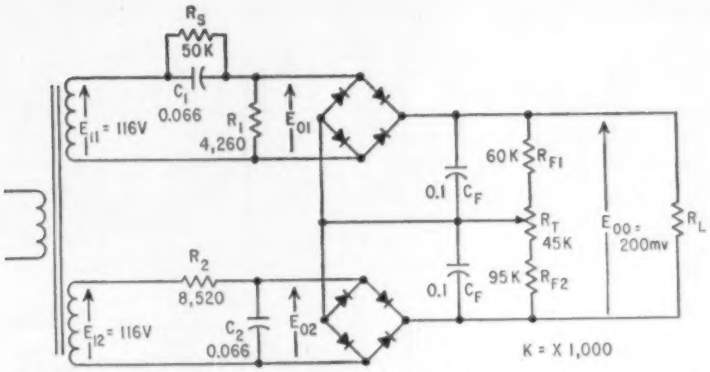
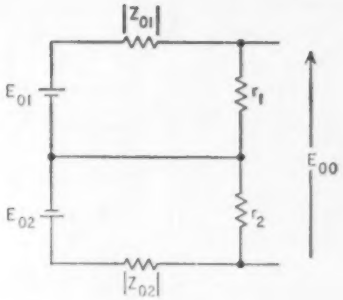


FIG. 1—Output voltage of full-wave discriminator is a function of difference in outputs across two bridges



$$|Z_{01}| = \frac{R_1}{\sqrt{1+R_1^2 C_1^2 \omega^2}} = \frac{R_1}{\sqrt{1.5}}$$

$$|Z_{02}| = \frac{R_2}{\sqrt{1+R_2^2 C_2^2 \omega^2}} = \frac{R_2}{\sqrt{3}}$$

FIG. 2—A d-c equivalent of the fullwave discriminator

Aircraft Alternator

quired output sensitivity is obtained across a load of 38,000 ohms.

Accuracy

Since the absolute value of ω is defined by the relation $T\omega$ = a constant, a percentage change in T effects an equal percentage change in ω. For absolute accuracy complementary temperature coefficients for T_1 and T_2 are selected to maintain stability over the −55 to +100 C temperature range.

If the device is to be calibrated at 20 C, an ambient temperature increase of 80 C should produce an apparent change in ω no greater than $2\pi\ (1/2) = \pi$ radians, or $\Delta f/f = 0.5/400 = \Delta T/T = 1{,}250$ ppm.

Hence, the maximum tolerable temperature coefficient for T is 15.6 ppm/C. If temperature coefficients of opposite sign are chosen for R and C, then only the difference of the two coefficients need be less than 15.6 ppm/C. Resistors were chosen with a positive temperature coefficient of 23 ±5 ppm/C. The capacitors have a temperature coefficient of −23 ±5 ppm/C. If warmup time cannot be provided, the temperature of the components should remain as nearly identical as possible. Therefore, the resistors are elaborately heatsunk and held within 3 C of ambient temperature.

Potentiometer R_T provides the initial discriminator calibration necessitated by the initial unbalance between E_{01} and E_{02}.

A d-c equivalent to the circuit in Fig. 1 is shown in Fig. 2 with r_1 equal to R_{F1} plus the upper portion of R_T and r_2 equal to R_{F2} plus the remainder of R_T. If all the constants are without error, zero output corresponds to $r_1/r_2 = |Z_{01}|/|Z_{02}| = 348/491 = 1/\sqrt{2}$. The percentage variation in r_1/r_2, required to balance out initial errors, is less than the 5-percent sum of the percentage errors in E_{11}/E_{12}, R_1, R_2, C_1 and C_2. The sum of r_1 and r_2 is large with respect to Z_{01} or Z_{02} to insure peak rectifier action. Specifically, the sum of the two is set equal to 200,000 ohms, and other values are: R_{F1} equal to 60,000 ohms, R_{F2} equal to 95,000 ohms, R_T equal to 45,000 ohms and C_F equal to 0.1 μf.

The d-c shunt resistance across C_1 should be large with respect to R_1 so that it does not disturb the frequency characteristic of the upper branch of the discriminator. If it is chosen 10 times R_1, its temperature coefficient is 1/10 as critical.

Ideally, the null point is independent of the amplitude of the input voltage. However, the off-null signal is a function of the input amplitude as well as frequency. An additional resistance in series with the upper-branch source impedance offsets the unbalance caused by distortion in the input signal.

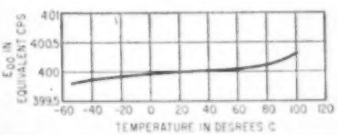


FIG. 3—Absolute accuracy of discriminator against ambient temperature

Rejecting Harmonics

If the harmonic content varies with the amplitude of the input signal, a change in input amplitude appears as a shift in frequency. Harmonics are rejected by designing the transformer so its primary inductance and the R-C combination reflected from the secondary resonate at 400 cps and by driving the device with a high-impedance source.

The output of a typical discriminator versus temperature is given in Fig. 3. The input to the discriminator is held at 400 cps while R_T adjusts the output to zero at 25 C. Ideally, the curve should be linear, but the temperature coefficient of the capacitors is slightly curved at 100 C and severely curved at higher temperatures. A similar departure from linearity is apparent at the low end.

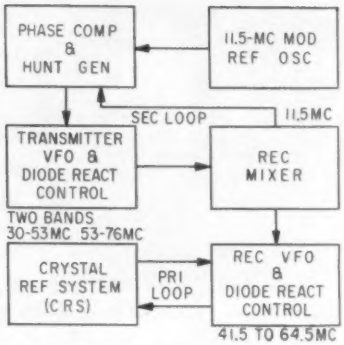


FIG. 1—Receiver-transmitter frequency control system, showing major frequency determining components

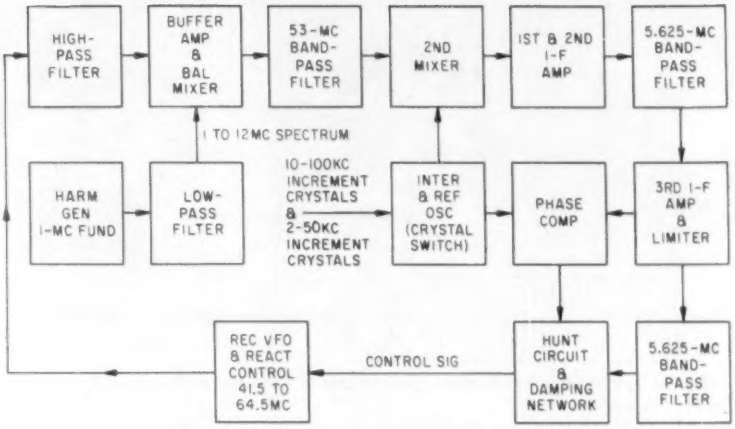

HIGH-PASS FILTER
BUFFER AMP & BAL MIXER
53-MC BAND-PASS FILTER
2ND MIXER
1ST & 2ND I-F AMP
5.625-MC BAND-PASS FILTER
1 TO 12MC SPECTRUM
HARM GEN 1-MC FUND
LOW-PASS FILTER
10-100KC INCREMENT CRYSTALS & 2-50KC INCREMENT CRYSTALS
INTER & REF OSC (CRYSTAL SWITCH)
PHASE COMP
3RD I-F AMP & LIMITER
REC VFO & REACT CONTROL 41.5 TO 64.5MC
CONTROL SIG
HUNT CIRCUIT & DAMPING NETWORK
5.625-MC BAND-PASS FILTER

FIG. 2—Crystal reference system is used for channel derivation and controls the local oscillator frequency within 3 kc of nominal channel

Controlled-frequency transceiver, operating in two bands, uses improved bandpass filter techniques that double the number of channels per megacycle of spectrum. Oscillator-stabilized system, used in military vehicular communications, is designed for 50-kc channel spacing and selects any of 920 channels between 30 to 76 mc

Mobile Radio System

By FRANK BRAUER and DON KAMMER
Communications Equipment Group, Avco Manufacturing Corp., Crosley Division, Cincinnati, Ohio

SINCE THE FREQUENCY spectrum cannot be enlarged, the present urgent need for more reliable communications channels can be satisfied by decreasing channel spacing, thereby stretching the usable radio spectrum. To accomplish this, the frequency-determining devices in a communications system must be designed for increased stability.

This article explains an approach used to stabilize the receiver and transmitter oscillators in a transistorized vehicular communications system (AN/VRC-12) developed for the U. S. Army Signal Corps.

50-Kc Channel Spacing

The system furnishes 920 channels of communication between 30 to 76 mc and operates from a 24-v vehicular battery. This equipment is a transistorized military vehicular system designed completely for 50-kc channel spacing. It shows certain advantages over present military 100-kc channel-spacing equipment that now uses three different receivers to cover the 20- to 54-mc range.

The receiver has a sensitivity of 0.3 μv for a 10-db signal-plus-noise/noise ratio and spurious responses are down 85 db. Transmitter output is 30 watts and all transmitted spurious frequencies are also down 85 db. The transceiver has ten preset channels and can be tuned manually or automatically. For automatic tuning, a servo system provides 3-second tuning between any two preset channels. The system operates over an ambient temperature range of -40 to $+65$ C.

Stable frequencies are derived by free running oscillators regulated by special control systems. A frequency control system implies a reference or standard, along with conventional regulation, direction, or error correction. Figure 1 shows the major frequency determining components.

Two frequency control loops are shown. The primary loop, the crystal reference system (crs), is used for channel derivation and controls the frequency of the receiver local oscillator within 3 kc of nominal channel frequency over the temperature range of -55 to $+85$ C. Since reception and transmission occur on the same channel, the stabilized receiver local oscillator is used as one of the references in the transmitter frequency control loop.

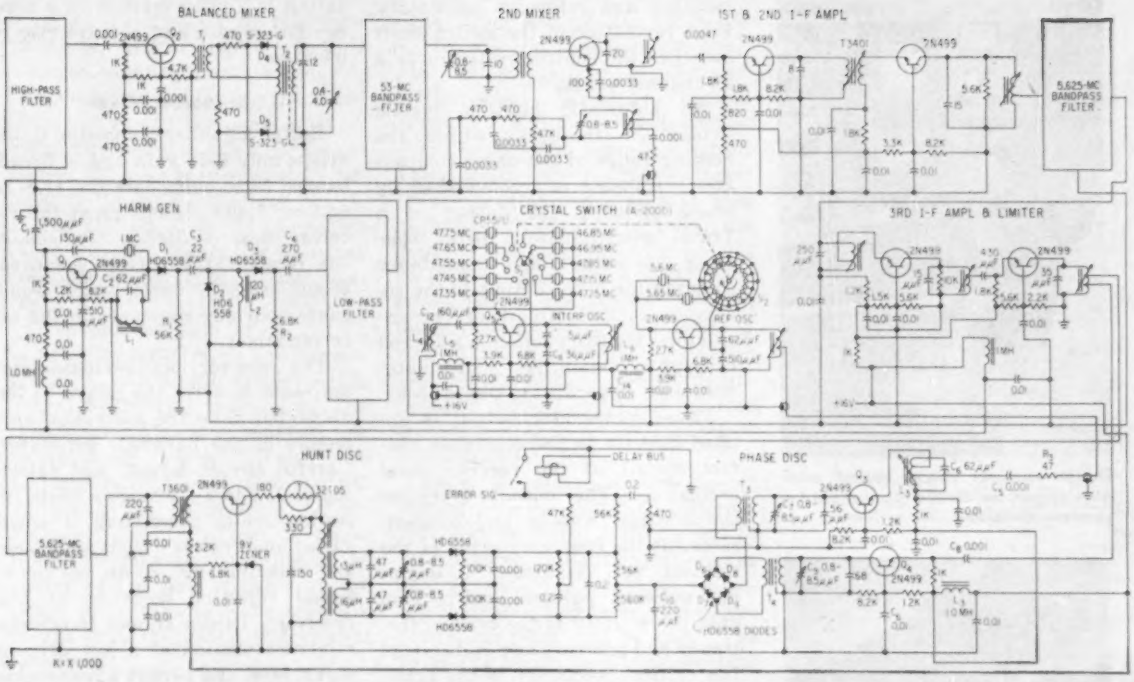


FIG. 3—Crystal reference system schematic. Hunting is achieved through instability, by phase splitting the output of a Travis discriminator, direct coupling one output and capacitance-coupling the other output to the reactance control circuit of the oscillator

Provides 920 Channels

The 11.5-mc modulated oscillator, controlled by a crystal discriminator afc loop, performs the sidestep function since it operates at the receiver intermediate frequency. The error signal in both controlled loops is derived by phase comparison of the controlled frequencies with crystal-controlled references. Frequency correction is obtained by using semiconductor reactance devices in the vfo circuits. Electronic hunting circuits in both loops bring the vfo within holding range of the phase comparators.

Two bands cover the 30 to 76-mc operating range of the receiver: 30 to 53 mc, and 53 to 76 mc. An 11.5-mc i-f was selected to obtain high- and low-side mixing of the receiver local oscillator. Operational range of the local oscillator is thus restricted to 41.5 to 64.5 mc.

Crystal Reference

A sampling of the local oscillator is fed to the crs (see Fig. 2). The 50-kc spacing is achieved by three successive interpolations.

The first interpolation occurs in the first or balanced mixer and divides the 23-mc band coverage into 1-mc increments. Since high and low mixing are employed in the balanced mixer, only the first 12 harmonics of a 1-mc crystal-controlled oscillator are required.

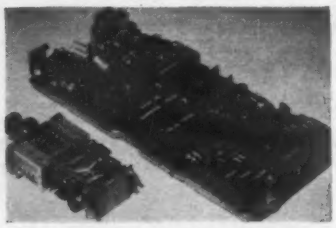
The second interpolation, which divides the 1-mc increments into 100-kc increments, takes place in the second mixer and is accomplished by a mechanically switched and synchronized crystal interpolation oscillator that employs 10 crystals in 100-kc steps between 46.85 and 47.75 mc.

Final interpolation is carried out in the phase comparator by synchronized selection of one of two crystals in the reference oscillator at 5.6 and 5.65 mc.

The switching frequency is the receiver local oscillator signal in the first or balanced mixer. Since this signal level is 25-db higher than the outputs of the harmonic generator, balancing of the first mixer provides nearly constant output at all receiver local oscillator frequencies. A buffer amplifier is used for isolation, since mixed products of the harmonic generator, present in the first mixer, fed back to the receiver would lead to spurious responses.

The crystal reference system filter complement keeps spurious responses down at least 85 db. The high-pass filter at the input of the crs further attenuates undesirable frequencies below 41.5 mc. The low-pass filter cuts off at 12 mc and attenuates undesirable frequencies, particularly those around the 53-mc first i-f of the crs. The 53-mc bandpass filter attenuates the image and half i-f responses. A bandwidth of 1,750 kc accommodates the 400-kc control range of the receiver local oscillator, the 900-kc range of the ten 100-kc increment crystals in the second crs oscillator, and the 50-kc

Design engineer checks crystal reference system for the 920 channel vhf f-m receiver-transmitter



Crystal reference system, covers removed, shows packaging techniques employed. Individually packaged, prealigned, plug-in assemblies facilitate field maintenance

displacement between the crs reference oscillator crystals.

The 5.625-mc bandpass filters limit action to the desired frequency signal in the crs second i-f. These filters prevent undesired signals, 1-mc either side of the desired frequency, from disturbing discriminator response necessary for automatic hunting.

Action of the harmonic generator causes first and second i-f responses every 1 mc. This desired interval response is predetermined by the receiver local oscillator, positioned within 400-kc of the required frequency. The nearest spurious signal is then 600-kc away.

The proper crystals in the interpolation reference oscillators are selected automatically by gear-coupling the crystal switches to the main tuning system. The three second tuning on the overall system has a switching speed of 460 revolutions per minute for the interpolation and reference oscillators. Each revolution of the switch shaft switches the control system over a 20-channel range.

An automatic hunting system brings the frequency within the holding range of the phase comparator. Hunting is accomplished by phase splitting the output of a Travis discriminator, direct coupling one output, and capacitance coupling the other output to the reactance control circuit of the oscillator. Hunting action is achieved through instability and automatically stops during phase lock.

Phase comparator output is applied directly to the reactance control circuit of the receiver local oscillator. The output overrides the hunting voltage and compensates for the frequency error of the receiver local oscillator. A damping network reduces control loop gain below unity at the critical frequency and prevents loop instability. The critical frequency is the error frequency at which the loop phase shift is 360 deg. And here instability occurs if the loop gain is greater than unity.

The maximum frequency error of the controlled oscillator is determined solely by the additive errors of the various crystal oscillators. A total of 13 crystals, used with 12 transistors, in the crs provides the 920 crystal controlled channels.

Harmonic Generator

As seen in Fig. 3, transistor Q_1 is connected in a common-base circuit. Oscillation is achieved with 100-percent feedback from the collector tank to the input circuit through the 1-mc series-mode crystal. Capacitor C_1 corrects the oscillator frequency to within plus or minus five cycles of the nominal 1-mc. The transistor is driven into saturation, and the waveshape across C_2 and L_1 is clipped on half the cycle.

This waveshape passes through a clipper network D_1 and R_1. This square wave is differentiated in network C_3 and D_2. Coil L_2 suppresses the lower order harmonics, and evens amplitude spread. Diode D_3 and R_2 act as a second clipper. Capacitor C_4 and input resistance of the low-pass filter form a second differentiating network. Thus the output is a pulse train with a 1-mc repetition rate and a pulse rise of 0.03 μsec.

Balanced Mixer

Buffer amplifier transistor Q_2 develops only 6-db gain and is broadbanded to accommodate the 41.5- to 64.5-mc input signals from the receiver local oscillator. It isolates the receiver tuner from balanced-mixer cross products which would cause spurious responses in the receiver mixer.

The receiver local oscillator signal, used to drive the mixer, is 30-db higher than the individual harmonics of the harmonic generator. Careful circuit layout, and shielding of T_1 and T_2, provide a 30-db rejection while permitting a small variation of mixer output amplitude and meeting the 85-db spurious-signal rejection demands of the receiver. Diodes D_4 and D_5 achieve mixer saturation at a low driving signal level and permit a reasonable variation in driving level without upsetting the balance. The tuned output is essentially an end section of the 53-mc filter. Net loss of the balanced mixer, referred to the power level of the harmonic generator individual harmonics, is 10 db.

Phase Discriminator

Capacitor C_9 couples the fixed input of either 5.6 or 5.65 mc to an input tank, C_8 and L_3, which is tuned to 5.625 mc. Resistor R_3 minimizes

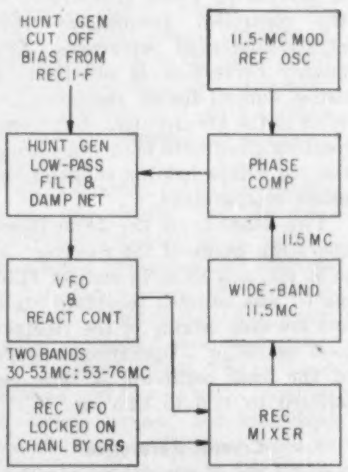

HUNT GEN CUT OFF BIAS FROM REC I-F
11.5-MC MOD REF OSC
HUNT GEN LOW-PASS FILT & DAMP NET
PHASE COMP
11.5 MC
VFO & REACT CONT
WIDE-BAND 11.5MC
TWO BANDS 30-53 MC; 53-76 MC
REC VFO LOCKED ON CHANL BY CRS
REC MIXER

FIG. 4—Transmitter frequency control (secondary control loop) block diagram

effects of the wide impedance swing of the buffer input on the reference oscillator. Buffer amplifier Q_8 is a common base transistor whose collector output is applied to the tuned circuit of C_7 and the primary of T_3 which is tuned to 5.625 mc. Transformer T_3 secondary output is applied to the ring modulator D_6, D_7, D_8 and D_9. Capacitor C_8 couples an input from the crs limiter to driver amplifier Q_9, a common-base transistor.

The tank, primary of T_4 and C_9, is tuned to 5.625 mc. The secondary of T_4 couples the driver section output to the ring modulator. The diodes are matched impedance, low conductance pairs. They are matched to hold residual d-c output voltage as low as possible. A d-c voltage, resulting from a phase difference between the output of the buffer and driver sections of the phase discriminator when they are on the same frequency, is developed across C_{10}.

Crystal Switch

The crystal switch interpolation oscillator, Q_{10}, is a high-frequency transistor, connected in a Colpitts oscillator circuit. Oscillation is sustained by feeding back a portion of the energy from the collector tank circuit into the emitter circuit, through switch S_1 and its properly selected crystal. Feedback is controlled by the ratio of the 5-$\mu\mu$f capacitor and C_{11}. The C_{12} and L_4 network compensates for stray capacitance due to switch leads and operates on the crystal frequency.

The crystals themselves are series-mode third-overtone crystals (CR55/U) having a frequency stability of 50 ppm. Oscillator output is tapped off the collector tank circuit and fed through a 50-ohm coaxial cable into the crs second mixer through a connector. Decoupling network L_5 and the 0.01-μf capacitor prevent the oscillator output from getting back into the 16-v regulated bus.

The reference oscillator is basically the same circuit as the interpolation oscillator, operating at either 5.6 or 5.65 mc. Each reference-oscillator crystal, used once with each interpolation-oscillator crystal, achieves the final 50-kc spacing. Decoupling network L_6 and C_{13} keeps the 5.6 and 5.65-mc signal from leaking into the 5.625-mc i-f via the interpolation oscillator, as well as into the i-f itself.

High-speed operating ganged switches S_1 and S_2 are mechanically linked to the main tuning capacitor. These make-before-break switches always present two inputs at ring modulator D_6 thru D_9 of the phase detector and prevent a large undesired residual d-c output. One revolution of the switch for each megacycle represents a speed of nearly 500 rpm when a tuning requirement of three seconds is imposed on the servo operated receiver transmitter. A cam-operated switch withstands this speed.

Close tolerances achieve proper crystal selection with 20 different reference oscillator positions and 10 interpolation oscillator positions for each revolution of the shaft. Molding the cams maintains these close tolerances from unit to unit. The reference oscillator is well shielded from the interpolation oscillator by heavy metal housing.

Transmit Frequency

Transmit channels are derived from the receiver local oscillator, controlled by the crs (See Fig. 4). The transmit frequency is sampled by the receiver, and the receiver mixer output frequency of 11.5 mc is compared in a phase comparator with the output from a 11.5 mc modulated afc reference oscillator.

The error signal from this phase comparator is applied to a semiconductor reactance control device on the transmitter vfo to maintain channel frequency. Modulation is accomplished at a single frequency thus affording constant modulator sensitivity. Also, the modulator circuit parameters are easier to control at the single lower frequency.

The transmit frequency is fed directly into the receiver mixer from the transmitter vfo with the B+ removed from the receiver r-f amplifier.

A low-pass filter, inserted into the control line, attenuates the 11.5-mc signal leaking into the control from the phase comparator. The 75 db attenuation is obtained near i-f harmonic crossovers of 34.5, 46.0, 57.5 and 69.0 mc.

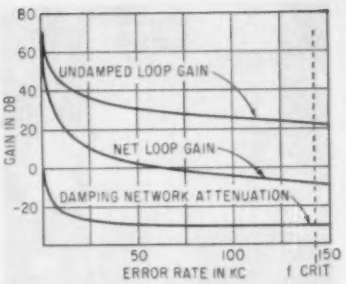


FIG. 5—Frequency-control-loop gain

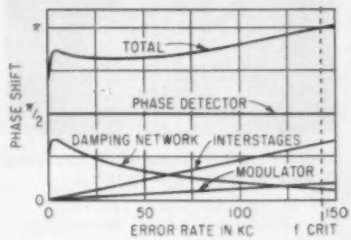


FIG. 6—Frequency-control-loop phase shift characteristics

Hunting is accomplished by a multivibrator operating into the reactance control circuit of the vfo. The multivibrator is biased with the rectified 11.5-mc signal derived from the receiver i-f after crystal frequency selection.

Figure 5 indicates gain characteristic of the transmitter frequency control loop vs sinusoidal error rate or modulation. Loop gain at the critical frequency is −10 db or less and the critical frequency occurs above 100 kc.

Frequency-control-loop phase shift is shown in Fig. 6.

The speech limiter in the transmitter prevents deviation in excess of 15-kc.

The control loop also overcomes the hunting voltage, compensates for vfo frequency error, and achieves maximum audio modulation because of the use of a voice-operated r-t relay.

The authors acknowledge assistance of engineers at the Signal Corps Engineering Labs., in particular A. C. Colaguori, A. Sills, and E. Jacubowics who formulated many concepts used in the crystal reference system. J. J. Lamplot, R. Midkiff and E. Wilson of the Communications Equipment Group of AVCO Crosley Division contributed significantly to the design of the frequency-control systems.

Memory rack—Apertured ferrite plate is used as memory or switch

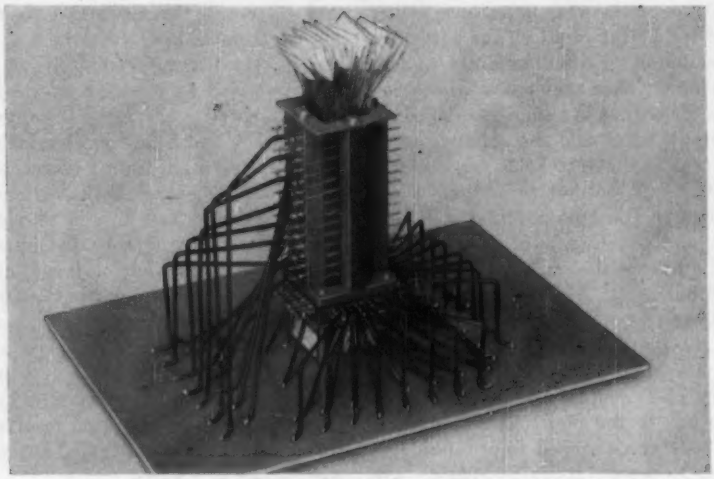


Plate assembly for a 256 by 7 bit memory. Seven pairs of printed storage plates are visible but stack of switch plates is hidden by supporting framework

End-Fired Memory Uses

Magnetic flux is induced around holes in ferrite plates to store and switch digital information. Plate properties can vary considerably from hole to hole without affecting memory accuracy. End-fired ferrite plate memory operation is explained and transistor drive and regeneration circuits are described

MAGNETIC CORE memory elements become impractical in million-bit memories. Cost of the magnetic core and the hand wiring techniques are a direct cause for the high cost of memories in digital data processing systems. With present memory cores used in a coincident-current system, noise output increases as memory size increases and tends to place a maximum practical upper limit. Ferrite-plate memory and switch elements can reduce cost and size.

Ferrite Plate

The developmental plate shown in Fig. 1 contains 256 holes in a 16 by 16 matrix. The outside dimensions of the plate are approximately 0.83 by 0.83 in. and the 256 holes are 25 mils in diameter, on 50-mil centers. It is fabricated from ferrite powder in a single pressing operation. Heat treatment of the plate produces the square hysteresis loop characteristics necessary for memory application. Because the ferrite material is nonconducting, at least one of the windings necessary for memory application may be printed on the surfaces of the plate.

Ninety percent of the total flux change which occurs around an aperture driven by alternate set and reset pulses plotted against the pulse amplitude is shown in Fig. 2. The set and reset pulses are of equal amplitude. The curves represent the limits and the mean of corresponding holes in a small sample of plates of the type used in the experimental memory.

One of the significant parameters which can be abstracted from the plot is the starting field. Below the starting field value, which in this case is approximately 175 milliampere-turns, no appreciable switching occurs.

Above the starting field the flux-current relationship is almost linear. Since application of more intense fields to a hole in a plate will continually increase the reversal flux, switching time remains approximately constant at 1.7 μsec for excitations greater than 250 ma-turns.

To insure that flux penetration about an aperture does not extend beyond the midpoint between apertures, net switching current must not exceed 500 ma-turns.

Memory System

Irregularities in the ferrite material from hole to hole is overcome by using two corresponding holes in adjacent plates to store each bit of information.[1] This reduces the tolerance requirements of the system. Using two holes for each bit of information also allows the information content to affect the polarity rather than the amplitude of the output signal.

The direction of flux used to define a stored ONE, a stored ZERO, and the cleared state is shown in Fig. 3. Information content of a location is sensed by determining which one of the two apertures containing the information must be switched to bring

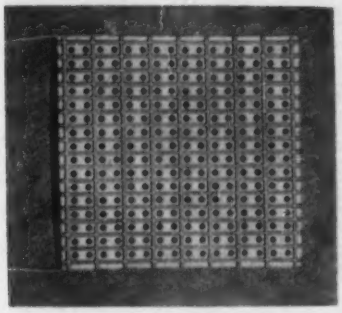


FIG. 1—Outside dimensions of ferrite plate are 0.83 by 0.83 in.

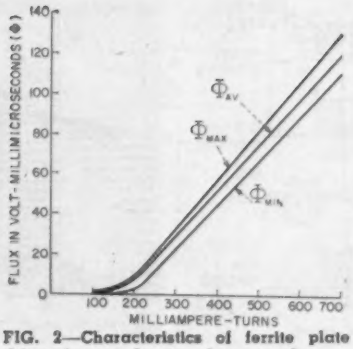


FIG. 2—Characteristics of ferrite plate driven by equal set and reset pulses

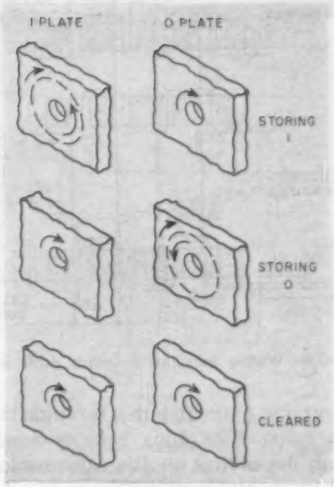


FIG. 3—A stored one, a stored zero and the cleared state in two-hole per bit system are defined by flux direction

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Ferrite Plates

the location to a cleared state. The wiring between a switch plate and one pair of storage plates is shown in Fig. 4. Wiring for the 256-word memory is shown in Fig. 5.

To read from a specific location, a clear pulse is sent through the address wire which links the switch with its storage location. This current causes a flux change around one of the storage aperture pairs which induces a positive or negative voltage pulse across the terminals of the digit rewrite winding. Polarity of the pulse depends on which of the two apertures was switched by the clear pulse; that is, on whether the interrogated location held a ONE or a ZERO.

To write information into a location, currents are sent along both the address line and the digit rewrite winding. The location must first be cleared. A current opposite in polarity to the one used to read is then sent along the corresponding address line at the same time a smaller current is sent along the digit rewrite line. Amplitude of the currents is adjusted so that flux switching can occur only where the digit rewrite line and the address line intersect. Switching takes place only in one of the two apertures since the digit rewrite current adds to the address current in one aperture and subtracts in the other. The sum of the currents exceeds the starting field while the difference is generally less than this field. If the digit rewrite current is reversed, the sum and difference of the currents will appear in opposite apertures.

The number of plates used for storage is twice the number of bits per word, with all the bits of each word lying along the same address line. Each of the 256 address wires shown pass through corresponding apertures in the magnetic switch and each pair of storage plates. The bits of each word are read out of and written into the memory in parallel, with one sense amplifier and one digit rewrite driver per pair of memory planes.

Magnetic Switch

The magnetic switch stack contains one plate for every pair of storage plates, and is threaded with sixteen row windings, sixteen column windings, and one d-c bias winding.[5] The d-c bias winding can be seen in Fig. 4. The column and row windings are shown in Fig. 5.

For read operation, the bias is counteracted in a selected column of holes by sending a current pulse approximately equal to the steady bias current through the column winding. The current rise and fall times should be controlled to limit the amplitude of noise currents induced in the address wires passing through the selected column. At the same time, a current of similar amplitude and rise time is applied to the selected row winding. The currents flowing through the selected row and column switch the flux around the aperture where they intersect. A current of about half the magnitude of the row current is induced in the address wire passing through the aperture. The current flowing in the address wire clears the memory locations. Polarity of the voltages induced in the digit rewrite windings at the cleared locations determines the information content of the interrogated location.

For write operation, an interval of time is allowed for flux switching in the cleared memory location to be completed before the digit rewrite current drivers are turned on. Each driver sends a positive or

* Now with General Electric Research Laboratories.

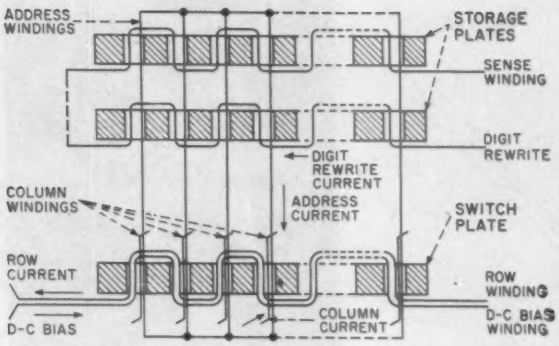

FIG.4—Wiring between a switch plate and storage plates

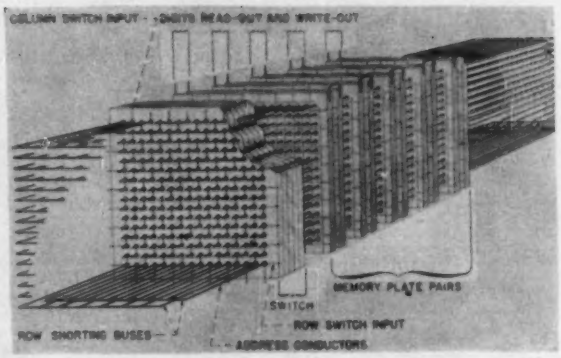

FIG. 5—Wiring for a 256-word memory with 4 bits per word

negative current pulse through the corresponding digit rewrite winding, depending on the information to be written into the memory. As soon as digit rewrite currents are established, the row and column currents flowing through the switch are turned off. This permits d-c bias to return the selected switch location to its original state, which in turn induces a set current pulse in the corresponding address winding. The pulse, together with already existing digit rewrite currents, switches the flux in the selected memory location and completes reentry of information into the memory.

Magnetic Switch Driving

The selection system by which the desired magnetic switch row and column windings are pulsed is shown in Fig. 6. Row and column pulses are generated by current drivers and steered through the selected row and column windings by transformer-coupled transistor switches. The transistor switch is selected by a diode decoder with inputs from the flip-flop register which may also be used as a binary counter.

The switch circuit uses an alloy-junction transistor with good saturation properties. A 2N140 is a good example. The decoding network selects one of sixteen switches by injecting a current into the base of the switch transistor to lower collector resistance. A total of two microseconds is sufficient to set the flip-flop register, decode and saturate the transistor switch. The current pulse to the switches is supplied by the current driver. In the experimental system, this pulse was approximately 50 ma in amplitude, 5 μsec wide at the base and had a rise and fall time of about 1 μsec. This current is steered through the selected transformer and switch winding. Since the transformer turns ratio is 10:1, secondary currents to the row and column windings of the magnetic switch are about 500 ma.

Using a transistor as a saturating switch has two advantages. Power dissipation for a given current is a minimum and transistor response time does not limit the rise and fall times of the applied current pulse. The time required to bring a transistor in and out of saturation is the only limit set by transistor frequency response.

Regeneration Network

A block diagram of the regeneration loop for each of the seven pairs of storage plates is also shown in Fig. 6. One end of the digit rewrite winding linking the 512 apertures in a pair of ferrite plates is grounded. The other end is connected to both the sense amplifier and the digit rewrite amplifier. During the read portion of a memory cycle, voltage at the input of the sense amplifier is about 20 mv, while during the rewrite portion the sum of 511 disturb voltages may be as high as 1 v. Since it is polarity rather than amplitude of the output signal which determines the contents of a location, the first stage of the sense amplifier can be d-c coupled, without special precautions against drift. The discriminator in the sense amplifier senses the p larity difference between the output voltage of the first stage at the time of sensing and the output one microsecond earlier.

A circuit diagram of the sense amplifier is shown in Fig. 7. It was designed to recover its sensitivity within 2 μsec after the end of the disturbance due to the digit rewrite pulse.

The first stage Q_1 is a linear amplifier for memory output signals and is cut off during the digit rewrite signal. Transistor Q_1 is cut off to avoid saturation and long turn-on times by a −6-v pulse. The pulse, which is transmitted directly to the emitter of Q_1 through D_5, is sufficient to overcome the digit rewrite voltage. Emitter resistor R_1 controls the mean current through Q_1 and therefore the level of the mean collector voltage when amplification takes place. Capacitor C_1 acts as a bypass to prevent degeneration. If plate *b* of C_1 were returned to ground, the antiparalysis pulse would cause the capacitor to charge and the amplifier would require an appreciable time to recover its initial state. Instead, plate *b* of C_1 is returned to diode D_1 which passes current during the sensitive period of the amplifier and presents a low impedance to small a-c signals. The antiparalysis pulse which applies a negative voltage to plate *a* of C_1 applies a slightly greater negative voltage pulse to plate *b*. Plate *a* of C_1 charges to approximately −3 v and plate *b* to approximately −5 v during the application of the antiparalysis pulse. When the pulse terminates, C_1 is polarized so that it will be rapidly discharged by Q_1 whose base, at this time, is at ground potential.

The output of Q_1 feeds emitter follower Q_2. Diode D_4 passes current before the application of the

strobe pulse. This allows C_2 to store the output level of Q_2 prior to read for comparison with the signal during read. It is this feature which allows the output voltage of Q_2 to drift without affecting circuit operation.

Network Operation

A typical operation with a negative sense signal input produces an excursion of 2 v at the emitter of Q_3, cutting off D_4. Capacitor C_2 still stores the output voltage of Q_2 before the start of the positive voltage excursion of 2 v, and Q_3 and D_5 remain cut off. The strobe pulse is now applied allowing D_5 to conduct and clamping the emitter of Q_3 to the voltage stored by C_2. Since the emitter of Q_3 is 2 v positive with respect to the emitter of Q_3, Q_3 conducts producing a negative output pulse. If the amplifier receives a positive signal input, the output of Q_2 goes negative and Q_3 remains cut off during the strobe period.

The digit rewrite driver uses complementary symmetry to either push or pull current through the digit rewrite winding. The circuit consists of 2 *pnp* and 2 *npn* transistors which supply current pulses of approximately 100 ma at 1 v with leading and trailing edges of approximately 1 μsec. The current drivers, used to excite the magnetic switch, use two transistors each. They are required to supply 50 ma pulses at 16 v, with rise and fall times of approximately 1 μsec. Rise and fall times are controlled by limiting the maximum positive and negative excursions at the current driver output. The remaining circuits associated with the experimental memory are conventional

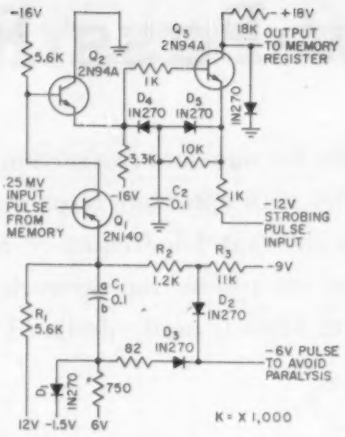

FIG. 7—Sense amplifier recovers within 2 μsec after a digit rewrite pulse

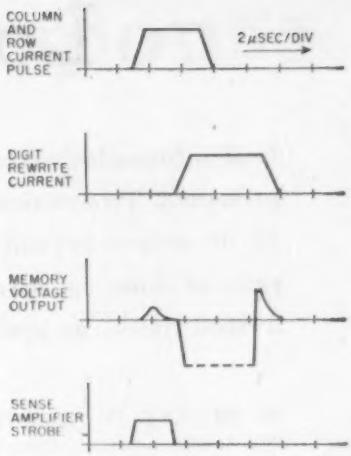

FIG. 8—Total access time for experimental memory is 10 μsec

Timing of the memory cycle is shown in Fig. 8. The row and column currents are approximatelv 5 μsec wide at the base. The 5 μsec time interval is distributed as follows. Approximately 1 μsec is required for the leading edge. The slow rise time prevents generation of noise currents in partially selected switch locations. Flux switching in the selected memory location starts just before the row and column pulses reach their peak, and continues for approximately 2 μsec. Two μsec are allowed for propagation time through the regeneration loop before the pulse terminates.

Flux switching which occurs during write takes approximately 2 μsec with another μsec allowed for decay of the digit rewrite current. Total cycle time is approximately 8 μsec. Total access time for the experimental memory allowing 2 μsec for address selection is 10 μsec.

This material was first presented at the 13th Annual NEC. The authors acknowledge the work of T. E. Gilligan.

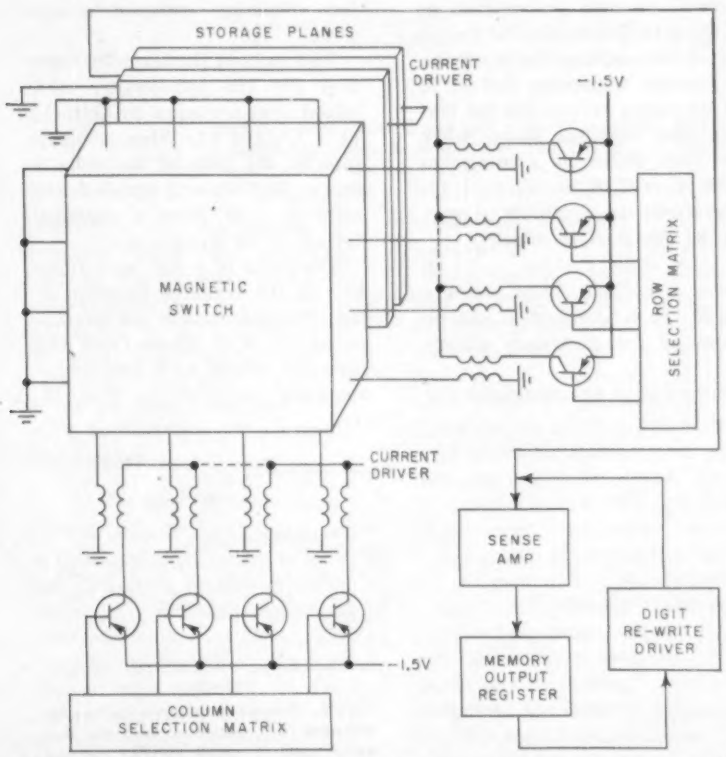

FIG. 6—Selection system for magnetic switch row and column windings and block diagram of regeneration loop for storage plates

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Low-Pass R-C Filter

Design formulas and graphs for one- and two-section low-pass R-C filters are presented. Two-section filter with optimum response effectively falls off at 12 db/octave beyond the constant low-frequency attenuation. When the ratio of shunt capacitors of the two-section network is selected within prescribed limits, an optimum filter is easily designed

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ALTHOUGH SINGLE R-C networks are widely used as low-pass filters, an optimum design for the two-section circuit is often overlooked. Low-pass filters seldom need any attenuation before the first breakpoint in the output response. But for a sharp, steep decrease in signal transmission beyond the breakpoint, the output R-C section in the two section filter should have little loading effect on the input section and a time constant equal to that of the first section.

The transfer function of the two-section filter shown in Fig. 1 is

$$M = \frac{1}{S^2R_1C_1R_2C_2 + S(R_1C_1 + R_2C_2 + R_1C_2) + 1} \quad (1)$$

where S is the Laplace form for $j\omega$. The two roots of Eq. 1 determine the breakpoints of the frequency response shown in Fig. 2. When the roots are equal and consequently the breakpoints coincide, the maximum fall-off of 12 db/octave is reached at the single resulting breakpoint. When the roots differ, the response fall-off is 6 db/octave after the first breakpoint and then 12 db/octave beyond the second breakpoint.

Optimized R-C Circuit

Because straight-line responses are only approximations of the actual response and rounding of the response curve occurs, a constant maximum fall-off of 12 db/octave beyond the flat low-frequency response exists when the roots differ by a minimum amount, or $R_2/R_1 = (C_1/C_2 + 1)$. Therefore, an optimum circuit can be designed in which

$$R_2 = (A + 1)R_1 \quad (2)$$

where $A = C_1/C_2$. Thus, when A and R_1 are determined, R_2 can be computed for maximum sharpness[1].

Values of A are restricted for optimum sharpness. The fall-off rate of an optimized filter with $A = 1$ is not materially greater than that of the equal-component filter, but constant fall-off sharpness is approached as A is increased. However, the approach to constant fall-off reaches a practical limit as A is increased beyond 5. A capacitance ratio of 5 is consequently a good value for obtaining constant sharpness.

The roots of the transfer function for the two-section optimized filter are equal to $(1/R_1C_1)(1 \pm 1/\sqrt{A+1})$. When A equals infinity, the ratio of the roots is unity. And when A equals 5, the ratio of 2.38 gives a practical fall-off of 12 db/octave.

The value of ωR_1C_1 as a function of the transfer function or transmission ratio M can be computed for R-C filters from the formulas given with the corresponding circuits in Fig. 1.

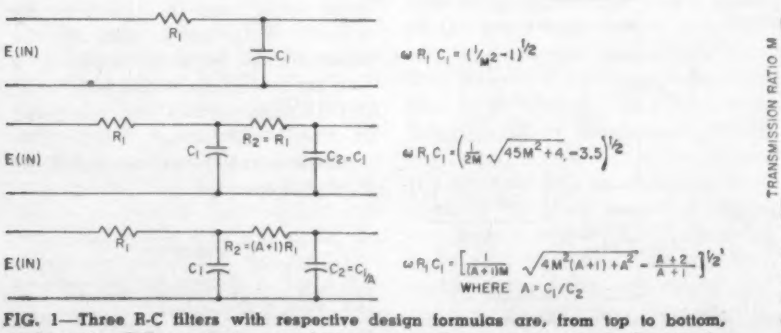

FIG. 1—Three R-C filters with respective design formulas are, from top to bottom, single-section R-C, two-section equal-component and two-section optimized networks

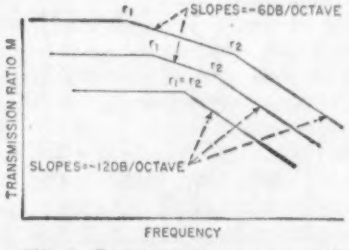

FIG. 2—Frequency-response curves for low-pass R-C networks indicate that equal roots of circuit transfer function gives single constant maximum fall-off. Both scales are logarithmic

With Optimum Response

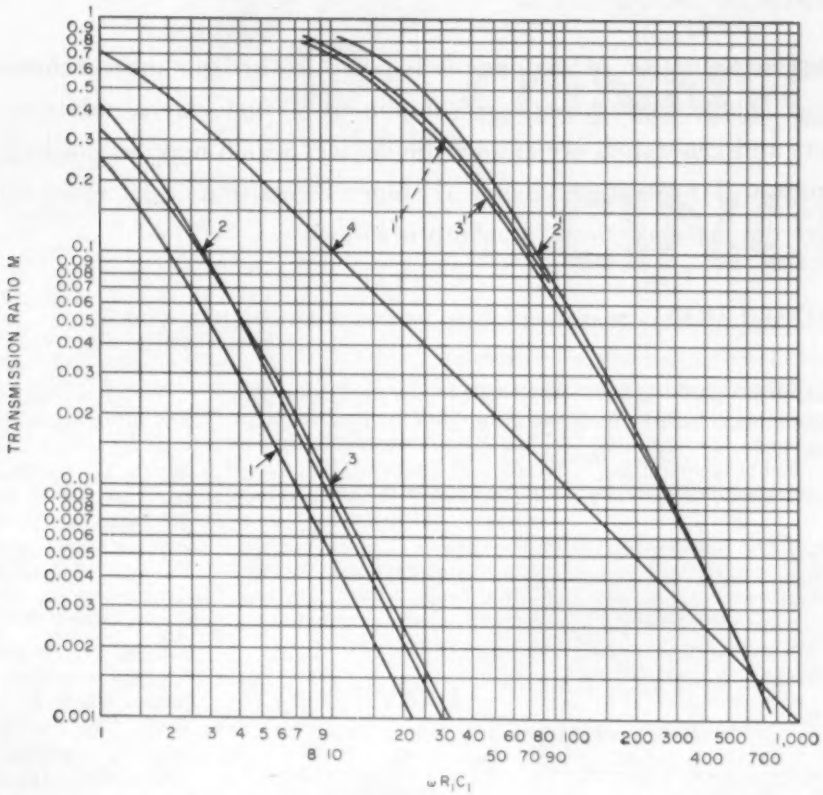

FIG. 3—Filters are designed with frequency-response curves 1, 2, 3 and 4 and then compared to the single-section filter with curves 1', 2' and 3'

Quantity ωR_1C_1 can also be determined from the graphical form of the formulas shown by the transmission — ωR_1C_1 curves of Fig. 3. Curves 1 and 2 give the responses of the optimized filters with $A = 1$ and $A = 5$. Curve 3 is for an equal component network, and curve 4 is for a single R-C section.

Design Procedure

First step in designing a one or two-section R-C filter is to select C_1 and A in the optimized circuit by considering component sizes, available values and prices. Then determine ωR_1C_1 as a function of the required M from curves 1, 2, 3 or 4 in Fig. 3, or by the appropriate formula of Fig. 1. Divide ωR_1C_1 by ωC_1 to determine R_1. Finally, find R_2 for the two-section networks from the formulas in Fig. 1 or from Eq. 2.

As a design example, suppose that a transmission ratio of 0.0015 at 60 cps is to be obtained with the optimized two-section filter and a capacitor ratio A equal to unity. Capacitors C_1 and C_2 are chosen as 0.5 $\mu\mu$f from size considerations. Curve 1 of Fig. 3 indicates that ωR_1C_1 is 18. Then $R_1 = 18/(2\pi 60 \times 0.5 \times 10^{-6}) = 95{,}500$ ohms. From Fig. 1 or Eq. 2, $R_2 = 2R_1 = 191{,}000$ ohms. Thus all parameters are determined.

The transmission responses for the four filters, adjusted for any desired transmission at a particular frequency, may be compared by shifting curves 1, 2 and 3 horizontally to intersect with curve 4 at the desired transmission ratio M.

When the curves are shifted to intersect curve 4 at the transmission ratio of 0.0015 they appear as curves 1', 2' and 3' in Fig. 3. Now the frequency responses of the two-section filters can be compared to a single section filter at any level. For example at a 3-db loss, which corresponds to a transmission ratio of 0.7, the frequency of the equal-component circuit is 9.8 times the frequency of the single-section. Frequencies of optimized circuits with A = 1 and A = 5 are 10.6 and 14.9 times the frequency of the single-section filter.

Reference

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Temperature Rise Chart

Heat-rise evaluation of equipment is possible through measurement of resistance change in a copper-wire component. Transformers, inductors, relays, motors and generators are among the devices which may be checked by this technique. Temperature change is shown directly in deg C when resistance change during operational warmup is known

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EQUIPMENT OPERATIONAL specifications often require electronic components to operate over an ambient temperature range of as much as −55 to +65 C.

The graph of Fig. 1 is based on the technique of determining internal temperature of a component by measuring the variation in resistance of a winding. It is applicable to any unit using copper wire. Similar graphs might be made for other conductor materials and temperatures.

By definition the temperature coefficient of resistance a is $(1/R)\ (dR/dT)$. Since a varies in a known manner over the temperature range 0-100 C, for copper of 100 percent conductivity, a equals $R/(234.5 + T)$.

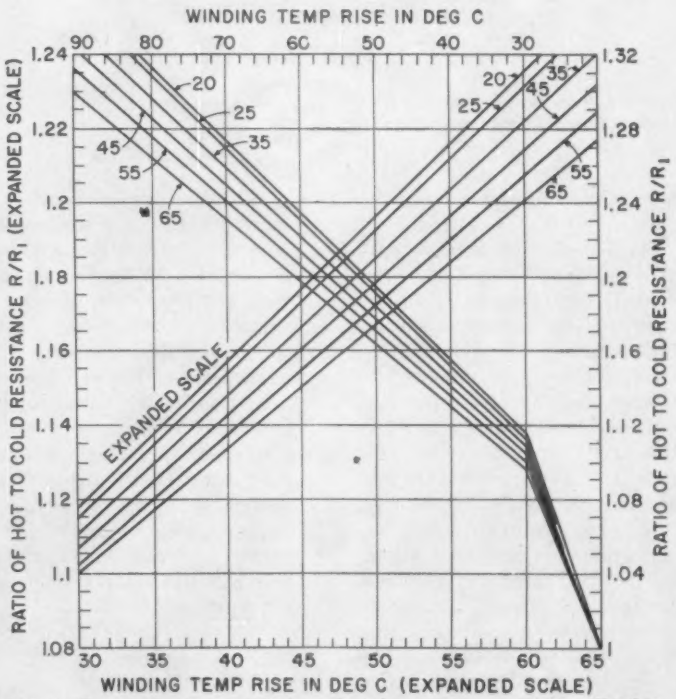


FIG. 1—Two scales are presented on chart for greater convenience. Numbers on curves refer to initial winding temperature in deg C

Equating the two formulas and integrating, we obtain $\Delta T = [(R/R_1) - 1]\ (234.5 + T)$, where ΔT is the winding temperature rise in deg C, R is the hot resistance in ohms, R_1 is the cold resistance in ohms and T is the final winding temperature.

Using the Chart

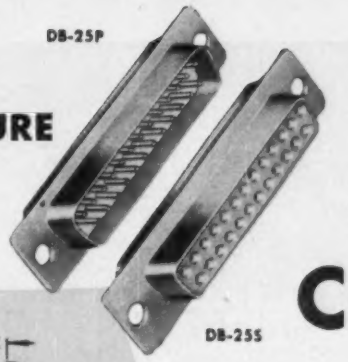
Suppose we are measuring the temperature rise of a transformer where $R_1 = 100$ ohms at 20 C. The resistance measurement is typically accomplished with a Wheatstone bridge. Selection of the highest resistance winding will generally result in greatest accuracy.

Several hours later, after thermal equilibrium has been reached, the hot resistance R is found to be 108 ohms at 25 C. The ratio R/R_1 is thus 1.08. Finding the intersection of the right-hand scale and line $T = 20$, we read 20 deg on the top scale. Since the ambient temperature variation during the test was +5 deg, the final transformer temperature rise ΔT is 15 C.

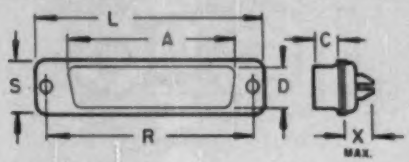
To demonstrate use of the expanded scale, suppose R_1 measures 50 ohms at 55 C. Sometime later a hot resistance R of 60 ohms is measured at an external ambient temperature of 55 C. The ratio R/R_1 thus equals 1.2. Passing from the left-hand ordinate over to the $T = 55$ line, and then directly down, we read $\Delta T = 58$ C.

D SUB-MINIATURE and DPX SERIES

CONNECTORS by CINCH



SUB-MINIATURES:
andard Pin and Socket Inserts.



size	A	C	D	L	R	S	X	weight
DA-15P	1 1/64	1 5/64	23/64	1 17/32	1.312	31/64	5/16	.013
DA-15S	1 3/32	1 5/64	5/16	1 17/32	1.312	31/64	1/4	.014
DB-25P	1 5/16	1 5/64	23/64	2 5/64	1.852	31/64	1/4	.023
DB-25S	1 33/64	1 5/64	5/16	2 5/64	1.852	31/64	5/16	.031
DC-37P	2 13/64	1 5/64	23/64	2 23/32	2.500	31/64	5/16	.035
DC-37S	2 11/64	1 5/64	5/16	2 23/32	2.500	31/64	1/4	.035
DD-50P	2 7/64	1 5/64	1 5/32	2 1/8	2.406	39/64	5/16	.035
DD-50S	2 5/64	1 5/64	27/64	2 1/8	2.406	39/64	5/16	.040
DE-9P	45/64	1 5/64	23/64	1 13/64	.984	31/64	5/16	.011
DE-9S	41/64	1 5/64	5/16	1 13/64	.984	31/64	5/16	.012

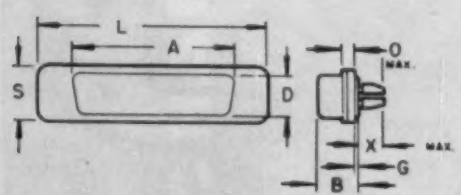
FRACTIONS ±1/64 Tolerance DECIMALS ±0.005 Tolerance

D SUB-MINIATURE SPECIFICATIONS:

Shell, including flange, steel or brass. Finish, Cadmium plate or Irridite. Contacts — No. 20, 5 ampere rating. Copper base alloy, gold plate finish. Insert arrangements — 5 plus coaxials in 9, 15, 25, 37, and 50 contacts.

Insulation material — Zytel 101, DIALL or Melamine.
Polarization — Keystone cornered shell.
Operating temperature —67° to +310° F.

D SUB-MINIATURES:
Hermetic Seal Pin Inserts.



size	A	B	O	D	G	L	S	X max.	weight
DAH-15P-001	1 1/64	23/64	3/32	23/64	1/32	1 35/64	1/2	5/32	0.021
DAH-15P-002	1 1/64	23/64	3/32	23/64	1/32	1 35/64	1/2	15/64	0.021
DBH-25P-001	1 5/16	23/64	3/32	23/64	1/32	2 3/32	1/2	5/32	0.027
DBH-25P-002	1 5/16	23/64	3/32	23/64	1/32	2 3/32	1/2	15/64	0.027
DCH-37P-001	2 13/64	23/64	3/32	23/64	1/32	2 47/64	1/2	5/32	0.037
DCH-37P-002	2 13/64	23/64	3/32	23/64	1/32	2 47/64	1/2	15/64	0.037
DDH-50P-001	2 7/64	23/64	3/32	1 5/32	1/32	2 41/64	39/64	5/32	0.041
DDH-50P-002	2 7/64	23/64	3/32	1 5/32	1/32	2 41/64	39/64	15/64	0.041

Variation in final dash number indicates type of contact terminal. —001 = eyelet type; —002 = solder pot type.

FRACTIONS ±1/64 Tolerance DECIMALS ±0.005 Tolerance

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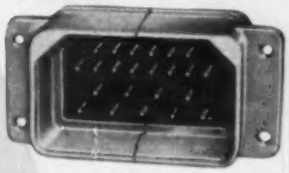
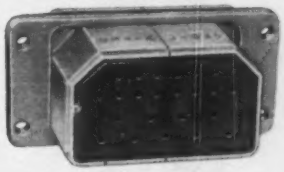
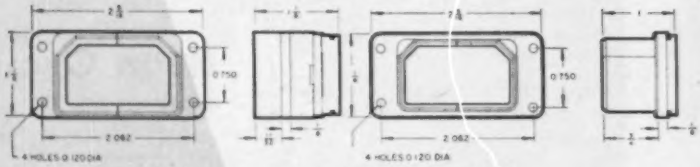


DPX 23-34P



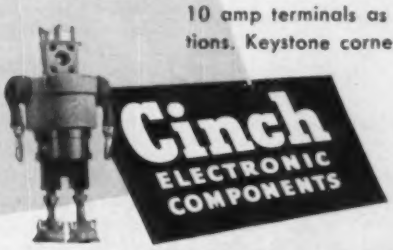
DPX 23-33S

DPX CONNECTORS:
Split shell. Pin and Socket Inserts.



DPX SPECIFICATIONS:

Shell, die cast aluminum alloy. Finish, cadmium plate with clear Irridite. Contacts—Plug, brass, Socket, phosphor bronze both with gold plate finish. Insulation material, Melamine type MME. Operating temperature —67° to +280° F. Available in 7 to 57 contacts in multiple variations of 5 and 10 amp terminals as well as coaxial terminations. Keystone cornered shell polarization.



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Control Regulates Iron Lung

MECHANICAL respirators such as the iron lung have been sustaining the life of patients with respiratory paralysis for a long time. However, they do not regulate air intake automatically according to need.

A feedback control system to overcome this problem was designed and constructed by G. H. Meyers of Bell Labs and G. A. Saxton, Jr., of the University of Ill. School of Medicine. It regulates oxygen intake according to needs by incorporating the patient in the control loop.

The system is shown in Fig. 1. Air exhaled by the patient is analyzed for carbon-dioxide concentration. A narrow plastic tube is fixed under one nostril with a small piece of adhesive tape; the other end is attached to the analyzer. Less than ten percent of the patient's expired

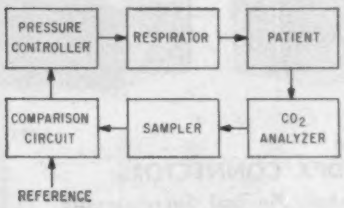

FIG. 1—Feedback control system includes patient in loop to regulate depth of breathing according to body needs

air is drawn through the analyzer by a small pump. This technique permits analysis of the patient's breath without discomfort to him.

The carbon-dioxide analyzer is a commercial instrument that detects CO_2 concentration by infrared absorption and provides an electrical output proportional to the amount of carbon dioxide in a gas passed through it.

The analyzer output is compared with a reference. If a difference exists, the error signal actuates a bleeder valve on the iron lung, causing it to readjust the depth of breathing.

The sampler circuit is shown in Fig. 2. Input is amplified by V_1 and applied through cathode follower V_2. The signal taken from the junction of R_1 and C_1 is applied to a Schmitt trigger circuit, V_3. Tube V_4

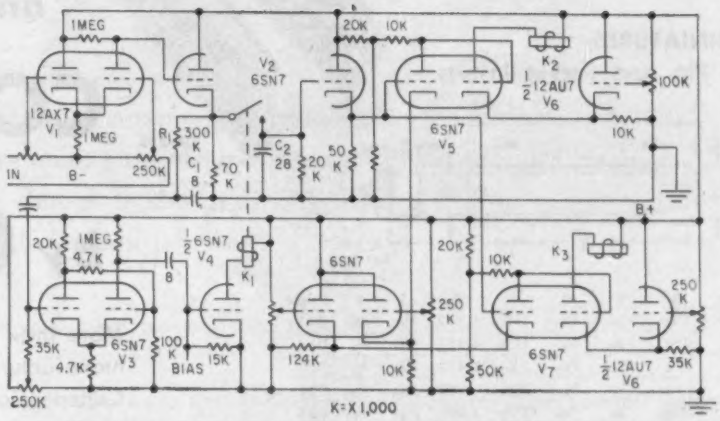

FIG. 2—Sampler circuit charges C_2 to level dependent on carbon-dioxide concentration. Comparison circuit controls relays K_2 and K_3 so that iron lung bleeder valve compensates errors

closes relay K_1 for a short time during exhalation. Sampling capacitor C_2 charges to a value depending on expired carbon-dioxide concentration.

Maximum and minimum limits are set for carbon-dioxide concentration. Tubes V_5 and V_6 and relay K_2 establish the upper limit; V_7, the other half of V_6 and relay K_3 establish the lower limit.

Biases are adjusted so that relay K_2 is energized and relay K_3 is deenergized when carbon-dioxide level is within limits. When carbon-dioxide concentration is low, relay K_3 is also energized. When it is high, both relays are deenergized.

If concentration exceeds either limit, power is applied by the relays to a motor that is geared to the bleeder valve on the iron lung. The motor drives the valve in a direction that will correct the error.

Neon Oscillator Rings

By RONALD L. IVES Palo Alto, Calif.

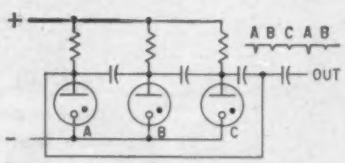

FIG. 1—Deliberate mismatching of components is required to make the neon lamps in this ring-of-three oscillator fire in sequence

NEON RING oscillators may be applied to a variety of sequential switching operations. Rings of three, four and five lamps can be constructed using available components with reasonable assurance of consistent behavior during the useful life of the neon lamps.

These oscillators require limited power and offer operating cycles of various lengths in the audio and subaudio frequencies.

One form of a two-lamp oscillator, which provides sequential output pulses of alternating polarity, was described in ELECTRONICS, pp 110-112, May 23, 1958. The ring of three shown in Fig. 1 has a consistent direction of rotation only if

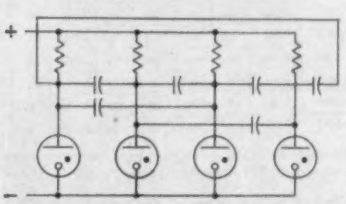

FIG. 2—Although ring-of-four cross-connected oscillator will fire in sequence, order of firing is difficult to establish

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Input Power (total) 3.8 watts	Input Power (total) 5.6 watts	Generator: Input Voltage 10 v	Output Power 4.0 watts	Linearity .5%	Accuracy 7' error max.	Accuracy 30' max. error spread	Accuracy 7' error max.	Accuracy 7' error max.	Accuracy 7' error max.
Stall Torque .15 oz in min. .20 oz in nom.	Stall Torque .3 oz in min.	Output Voltage 0.13 v/1000 rpm max.	No Load Speed 20,000 rpm	Null E at EZ .015 v	Null 30 mv max.	Torque Gradient 2200 mg-mm/deg.	Null 30 mv max.	Null 30 mv max.	Null 30 mv max.
Max. Weight 29 gms.	No Load Speed 6500 rpm min.		Input Voltage 28 v DC	Phase Shift 15 deg. lead	Phase Shift 8.5 deg. lead	Input Power .54 watts	Phase Shift 8.5 deg. lead	Phase Shift 9 deg. lead	Phase Shift 11 deg. lead

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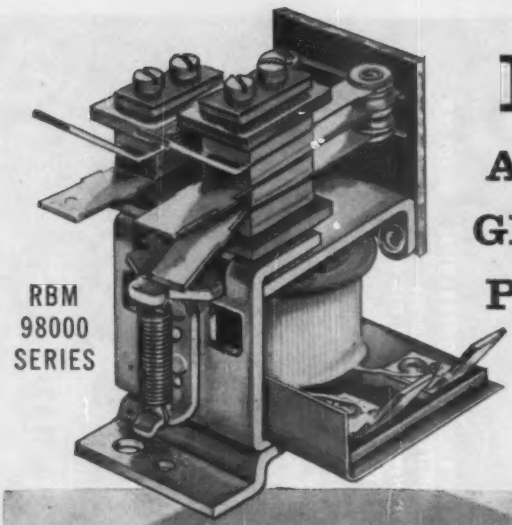
Clifton Heights, Pennsylvania



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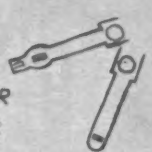

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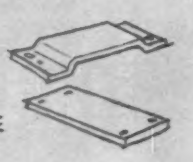

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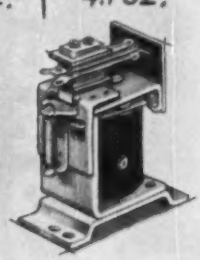

Consult Your Local RBM Product Application Engineer or Write For Bulletin 1060

RBM Controls Division

ESSEX WIRE CORPORATION, LOGANSPORT, INDIANA

the components are mismatched.

The cross-coupled ring of four in Fig. 2 will perform consistently for some thousands of cycles with deliberately mismatched components. However, it performs erratically with matched components and is always hard to adjust for a specific firing order.

A group of neon rings was developed that maintains a fixed sequence of firing. The most flexible and also the simplest is shown in Fig. 3.

When first turned on, one of the lamps fires because of inherent inequalities in lamp properties, components or other factors. Firing causes about a 15-volt drop in anode potential of the conducting tube. This initial drop is coupled to all other anodes by capacitors, preventing the other lamps from firing.

As conduction continues, voltage on the other anodes rises as the anode capacitors are charged positively. However, the capacitors in the anode circuit of the conducting lamp are charged negatively because of conduction. When anode voltage of the conducting lamp falls below extinction value, conduction stops. The resulting rise in anode voltage is coupled to all other lamps in the ring by the anode capacitors.

Diodes are used in the cathode circuits to ensure that the next lamp in the sequence fires with the rise in anode voltage. When the original lamp was conducting, bias voltage was produced on its cathode. Part of this bias was applied through a diode to the lamp at the left. In turn, part of this was coupled to the lamp to the left of that. Finally, the smallest part of the bias was coupled to the cathode of the lamp to the right of the originally conducting lamp.

The rise in anode voltage that occurred when the originally conducting lamp was extinguished causes the lamp at the right to conduct because this lamp has the most favorable cathode bias for conduction.

Cathode-to-ground capacitors keep cathode biases substantially constant during switching. Actual bias voltages, measured in a ring of five in operation, are shown in Fig. 4. These voltages are considerably higher than those indicated by purely resistive computation because of storage in the cathode-to-ground capacitors. Accordingly, these bias voltages can be modified somewhat by changing capacitor values. In this circuit, they can be varied from about 0.5 to 0.05 C without impairing performance. However, all capacitors must have the same value.

A somewhat empirical formula

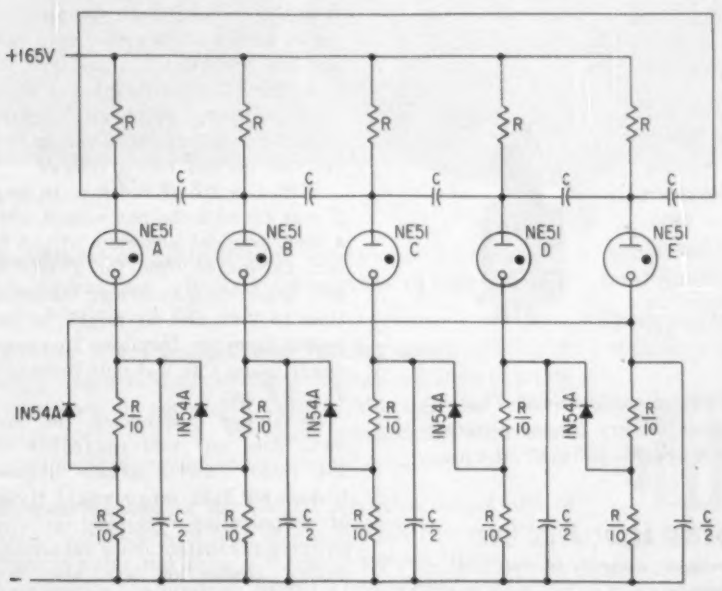

FIG. 3—By coupling different portions of bias from conducting lamp to other lamps, lamp with most favorable bias will be next to conduct

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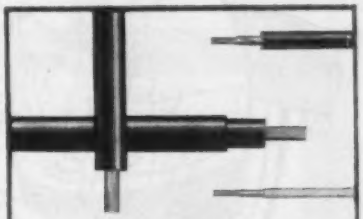

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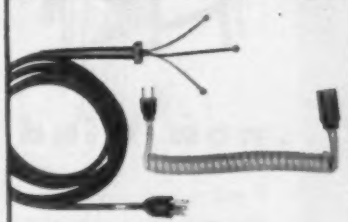

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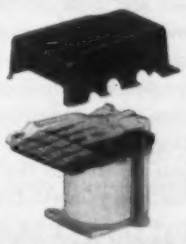

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CIRCLE 76 READERS SERVICE CARD

for performance of this neon ring oscillator is

$$T = 2.303\ R\ C \log_{10} \frac{E_s - E_e}{E_s - E_f}$$

where T is time of one cycle in sec (from first to second firing of same lamp), R is resistance in meg, C is capacitance in μf, E_s is supply voltage, E_f is firing voltage and E_e is extinction voltage.

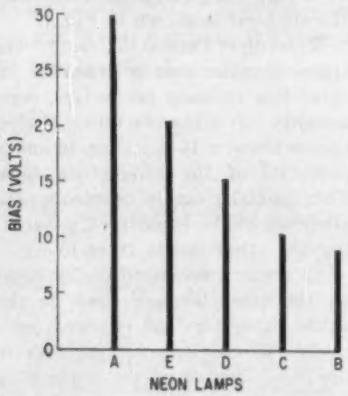

FIG. 4—Bias voltages on lamp cathodes are higher than might be expected because cathode capacitors store charge

If R in megohms is very much larger than C in microfarads, the formula holds within about 10 percent for cycles from 0.01 to 5 sec. Under these conditions, the neon lamps operate almost as independent oscillators. The triggering pulse from a lamp just extinguished comes nearly at the time anode voltage has risen to the firing level.

As the R-C ratio falls below about 10, T decreases because triggering takes place before anode voltage has reached normal firing voltage.

With $C = 0.5\ \mu$f and $R = 10$ meg, T was found to be one second with a measurement accuracy of ± 0.01 sec. Computed time for T is 0.98 sec. Doubling R to 20 meg increases time to 2.02 sec, as might be expected from the formula. However, quadrupling C to 2 μf only increases T to 2.8 sec.

At higher frequencies, the formula does not hold regardless of R-C ratio. This is largely because it does not take into account times of deionization, reionization and switching transient. Bias variations during conduction are also not taken into account by the formula.

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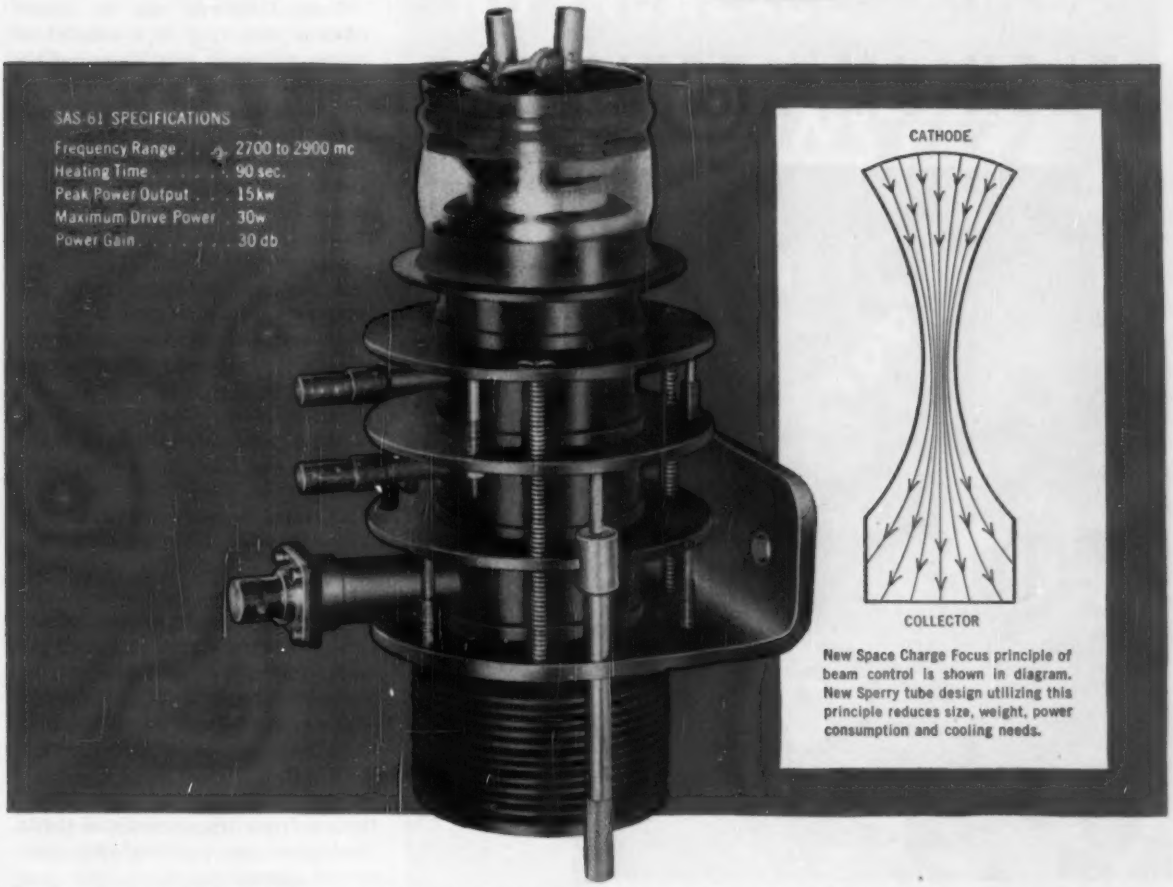
SAS-61 SPECIFICATIONS
Frequency Range . . 2700 to 2900 mc
Heating Time . . . . 90 sec.
Peak Power Output . . 15kw
Maximum Drive Power . 30w
Power Gain . . . . . 30 db
CATHODE
COLLECTOR

New Space Charge Focus principle of beam control is shown in diagram. New Sperry tube design utilizing this principle reduces size, weight, power consumption and cooling needs.

Available for immediate delivery, Sperry's new S-band transmitting tube is a 3-cavity pulse amplifier of high gain and extra-long service life.

Exclusive Sperry Space-Charge Focusing design eliminates heavy, cumbersome magnetic structures—a feature of prime importance in equipment design. Although the SAS-61 weighs only 6½ lbs., its sturdy construction withstands extreme vibration and environmental conditions.

Main applications for the SAS-61 are as an output tube in low-power radars, or as a driver for higher-powered klystrons in radar and linear accelerator systems. Its unusually long service life, however, makes it highly desirable for any application requiring 15 kw in the S-band. The SAS-61 with its internal tunable cavities is a *complete* microwave unit. No external equipment is required.

Sperry can deliver SAS-61 tubes in quantity at once. Write or phone your nearest Sperry district office.

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SPERRY GYROSCOPE COMPANY

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DIVISION OF SPERRY RAND CORPORATION

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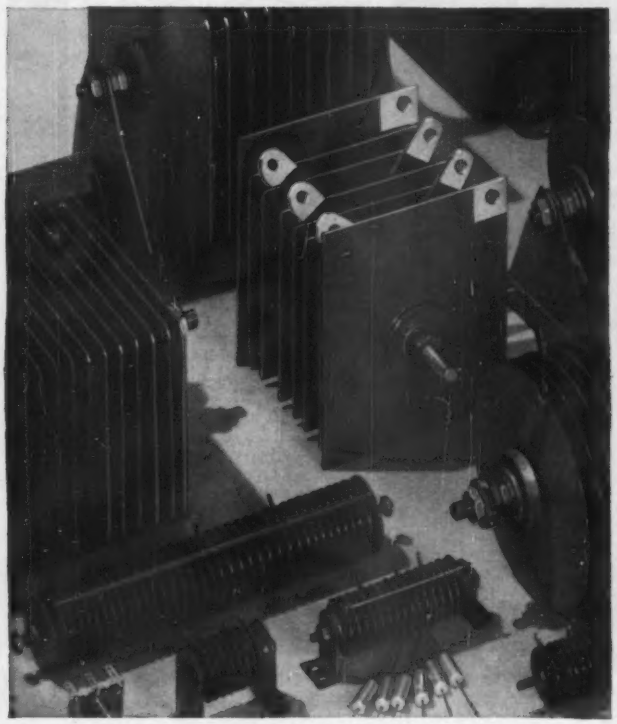

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DEPENDABLE RECTIFIERS SINCE 1924

lators, great changes in illumination cause small changes in period. Changes of period are of the order of one percent when illumination is raised from 30 to 1,000 footcandles. These changes are consistent.

Placing a ring of five in an environment where beta-gamma is 50,000 counts/minute causes both rate and sequence to become erratic. Removal restores rate and sequence promptly.

Control signals can be tapped from a neon ring in a number of places, the most suitable being the cathodes. With a capacitive tap on a lamp cathode in Fig. 3, output is a positive-going wave of about 3 volts amplitude with $R = 10$ meg and $C = 0.5$ μf. Amplitude can be increased to about 12 volts by reducing cathode-to-ground capacitance.

A tap may be taken from any lamp cathode to the grid of a tube. With suitable cathode bias on the tube, it can be biased on by the neon ring for 1, 2, 3, 4 or 5 fifths of a complete cycle. The 4/5 position requires close differential operation in that the bias change is much smaller.

Characteristics of available components place a definite limit on the number of lamps in a neon ring. Using 10-percent components and neon lamps with firing and extinction voltages within ± 1 volt of each other, rings of three can be made on a production basis. Rings of five require 5-percent components and lamp characteristics within ± 0.5 volt.

Good system grounding and protection from line surges and static discharges are essential for consistent operation.

A ring of eight requires the same circuit precautions, one-percent components, lamps matched within 0.25 volt and uniform illumination (level not critical). Because lamp characteristics change with use, no ring of eight tested would operate for as many as 100,000 cycles. Aging of lamps did not result in much improvement.

In practice, rings of more than five lamps can be made to work, but their usefulness is limited by instability of neon lamps now commercially available and their sensitivity

to extraneous influences. Although great extension of these ring oscillators is theoretically possible, cost of construction and maintenance increase as approximately the factorial of the number of lamps.

Experiments were made with cross connection of anode capacitors such as shown in Fig. 2. For rings of four and more neon lamps, there was a slight improvement in consistency (perhaps 10 percent). But the cross connection becomes inordinately bulky and costly as the number of lamps increases. For example, in a ring of 10 lamps using cross connection, 45 capacitors are required.

Calibrator Plots ADF Errors

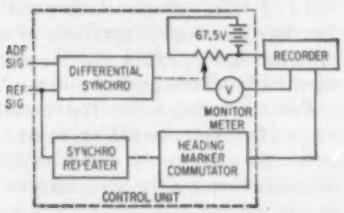

FIG. 1—Continuous plot of radio compass errors is made by comparing direction finder antenna position to gyro compass reference

FASTER and less costly determination of errors in aircraft radio direction finders may be possible with a new portable calibrator. The instrument, undergoing flight evaluation, provides a continuous record for all azimuth angles.

The calibrator was designed by Airborne Instruments, a division of Cutler-Hammer, in cooperation with Navy Bureau of Aeronautics.

Aircraft radio direction finders do not always point directly to the radio source. Existence and magnitude of errors depend on radio frequency, aircraft design, type of antenna installation and other factors not under the control of the designer or user of the radio compass.

These errors can be compensated, but first their direction and magnitude must be measured. The ADF calibrator is designed to provide an accurate, continuous record of the error of a direction finder.

The instrument comprises a con-

2½ Times
More Amperage
at
NO INCREASE in size

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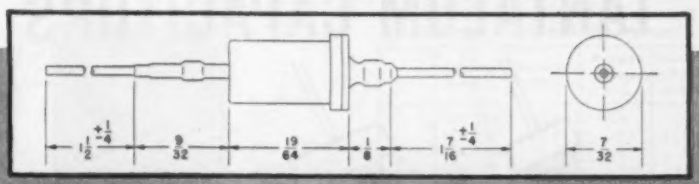
SILICON RECTIFIERS



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- Rated at **750** milliamperes yet so small in size.
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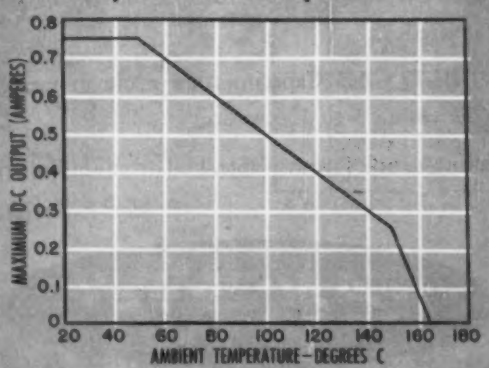

Write for New Bulletin 6.302

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North Chicago, Illinois, U.S.A. 8585A

DEPENDABLE RECTIFIERS SINCE 1924

Now for the FIRST TIME

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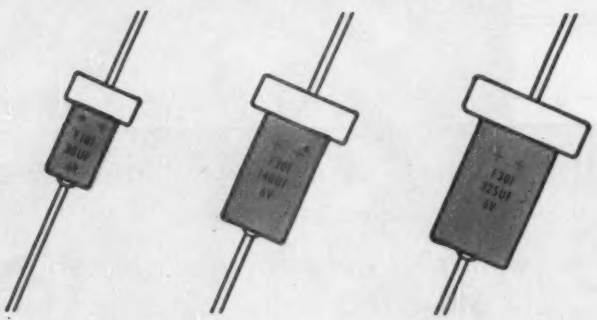
BLU-CAP*

TANTALUM CAPACITORS



Developed by Fansteel to meet the current demand for a dependable, utility tantalum capacitor at prices that will fit it into almost any product where capacitor reliability in small sizes is desired.

Fansteel BLU-CAP Capacitors are made in ratings from 1.75 to 325 mfd., 6 to 125 wvdc.

Engineering samples are available. Full details in Bulletin 6.120.

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North Chicago, Illinois, U.S.A.

C588A

RELIABLE TANTALUM CAPACITORS SINCE 1930

ventional chart recorder and a data converter control unit. Because of limited cockpit panel space in many aircraft, the control unit is mounted on the pilot's knee during the calibration flight. However, it can be mounted on the panel. The recorder may be placed at any available spot.

A block diagram of the calibrator is shown in Fig. 1. Synchro signals from the ADF antenna and from a stable directional reference such as a gyro-stabilized compass are compared by a differential synchro. As the aircraft flies a circular pattern over the ground radio station, the differential synchro shaft rotates in a direction and to a position determined by the error.

The differential shaft positions a potentiometer that picks off an analog of the error from a 67.5-volt battery. The polarity and magnitude of this voltage correspond to the direction and magnitude of the compass error. This d-c signal is used to drive the chart recorder.

Present procedures for making error charts are based on point-by-point measurements. One method requires turning the aircraft slowly on the ground and using a compass rose and optical sighting. Another requires flying clover-leaf patterns over a fixed point.

For low and medium-frequency compasses, point-by-point methods may be adequate. Errors usually change slowly over large angular regions. However, local reflections from power lines, proximity of the ground and other factors can affect accuracy.

With uhf direction finders, the problem has become more serious. The error curve is much less predictable with large changes occurring over a few degrees. In addition, error is often seriously affected by external aircraft equipment such as fuel tanks and armament racks. For these reasons, almost continuous sampling is required.

The photopanel method of making error charts provides greater accuracy than point-by-point methods. It involves making a photographic record of gyro and radio compass readings in one-degree increments. However, processing results is a formidable task.

The calibrator was compared

with the point-by-point and photopanel methods. The calibrator was claimed to be faster and to have better repeatability. Accuracy was said to be better than the point-by-point methods and about equal to the photopanel method. And, with the calibrator, results are available immediately.

Selective Calling Tested for Aircraft

TRANSISTORIZED circuits and modular construction are featured in a new aircraft selective calling system design now under test by Motorola. The new design uses computer pulse techniques to signal aircraft singly or in groups.

Operation is similar to that of Motorola's Selcal systems, but new techniques are employed in the design. These systems relieve pilots of continually monitoring radio channels, thereby increasing safety.

An in-flight alerting device—a bell, light or other signal—is activated whenever a radio message is intended for the particular aircraft. Activation of these devices in the aircraft selected is accomplished through a code transmitted along with the message and decoded by the airborn decoder units.

"Capabilities of the new system surpass existing equipment," Motorola engineers report, "in that all digits from 00000 to 99999 are acceptable." It is claimed that selected planes can be called in a fraction of a second with extreme reliability.

A newly developed group-calling feature permits alerting of all decoders in transmitter range, or of selected subgroups as determined by the operator. Code signals can be transmitted over single sideband, a-m or f-m radio and relayed to remote transmitter sites over carrier telephone links.

The decoder can be switched to respond to over 100,000 possible calls with equal reliability. Codes are easily set up, checked and switched by means of five rotary switches controlled from the front panel. For operation on more than one channel, decoders can be stacked within the aircraft.

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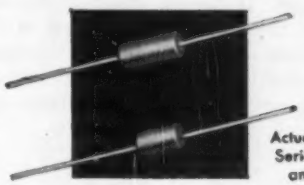

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SPECIFICATIONS AND ORDERING REFERENCES

	Catalog Number	Capacity in MFD*	Working Voltage D-C	Maximum Peak Voltage
100 SERIES	STA 152	5.5	6	8
	STA 157	3.5	10	12
	STA 162	2.0	15	18
	STA 167	1.5	20	24
	STA 172	1.2	30	36
	STA 177	1.0	35	42
	STA 179	0.7	50	60
	STA 181	0.6	60	72
400 SERIES	STA 452	11	6	8
	STA 457	7	10	12
	STA 462	4	15	18
	STA 467	3	20	24
	STA 472	2.4	30	36
	STA 477	2	35	42
	STA 479	1.4	50	60
	STA 481	1.2	60	72
200 SERIES	STA 252	28	6	8
	STA 257	17	10	12
	STA 262	11	15	18
	STA 267	8	20	24
	STA 272	6	30	36
	STA 277	5	35	42
300 SERIES	STA 352	115	6	8
	STA 357	70	10	12
	STA 362	45	15	18
	STA 367	35	20	24
	STA 372	23	30	36
	STA 377	20	35	42

*Standard Capacity Tolerances are minus 15%, plus 25%

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North Chicago, Illinois, U.S.A.

C589A

RELIABLE TANTALUM CAPACITORS SINCE 1930

The Semiconductor Hall-Effect Circulator

MOST PASSIVE transmission devices are reciprocal in nature. But with others, the nature of the transfer characteristic depends on whether the signal goes from some point A to another point B or from B to A. Gyrators, isolators and circulators are in the latter category of nonreciprocal devices. In a paper presented at WESCON by W. J. Grubbs of Bell Telephone Laboratories, the Hall-effect circulator was described.

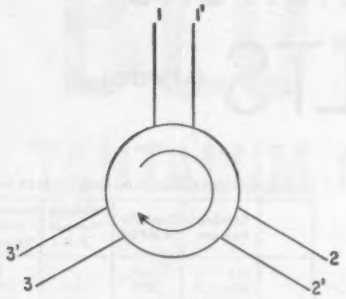

FIG. 1—Simple form of circulator

A circulator is a three-port, six-terminal, nonreciprocal passive device which circulates signals essentially in one direction only. The circulator shown in Fig. 1, for example, circulates signals in the clockwise direction only. An input signal on terminals 1-1′ is transmitted to terminals 2-2′. No signal appears at 3-3′. The same clockwise circulation occurs when a signal is applied to any one of the three terminal pairs.

Suppose now that a magnetic field is applied perpendicular to a current flow, as shown in Fig. 2. Current carriers are deflected sideways. A transverse electric field, perpendicular to both the magnetic field and the longitudinal current flow, is built up between the sides of the conductor. The net electric field makes some angle θ with the direction of current flow. This angle is known as the Hall angle. To a first approximation, its tangent is given by the product of the magnetic field and the Hall mobility of the major carriers in the sample. This approximation holds if the product of the majority carrier density and mobility is much greater than the same product for minority carriers. Hall-effect devices use semiconductors rather than metals since most metals have much lower mobilities.

If six equally spaced contacts are made to the edge of a slice of semiconductor as shown in Fig. 3 and a constant magnetic field is applied perpendicularly to the plane of the slice, the slice becomes a Hall-effect circulator for the proper value of magnetic field. In other words, the angle θ must be such that the net electric field produces no voltage between terminals 3 and 3′.

When a load is connected to terminals 2-2′ so that a current can flow, an additional Hall field is produced. It has the effect of decreasing the effective Hall angle in the sample. As a result, a stronger magnetic field is required to balance the circulator. The circulator can

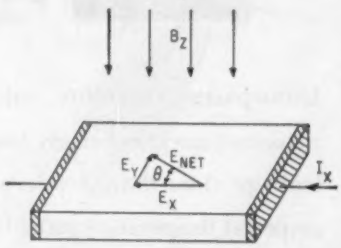

FIG. 2—Circulator with magnetic-field applied perpendicularly to current flow

be made to operate properly with a range of load resistances by adjusting the magnetic flux density.

Parallel Networks

Hall-effect circulators have been made which are quite symmetrical. To date, the best circulator made has an average reverse loss of 61 db and an average forward loss of 17 db resulting in an average transmission ratio of 44 db. Any two pairs of terminals act as an isolator with 17-db loss in one direction and 61-db loss in the opposite direction. But symmetry depends primarily on having a regular 60-deg angular spacing between the six edge contacts. This spacing is difficult to achieve. Also, it is almost impossible to obtain a specific input admittance or operating impedance level since this characteristic is almost directly proportional to the material's conductivity and the reciprocal of the sample thickness.

When a resistance network is connected in parallel with the circulator, imperfections can be removed effectively. And other interesting features are made available. For example, the forward loss can be decreased by using a larger magnetic field. Conversely, if a greater forward loss can be tolerated, a smaller magnet can be used.

With any fixed magnetic field, circulation is obtainable with any load admittance from about ten times the normal admittance down to zero or open circuit. Since the admittance of the circulator with the network changes only slightly over this range, the forward loss becomes high when a widely different load admittance is used because of admittance mismatch. Also, resistance networks can provide circulation when an essentially symmetrical circulator is used with a different load conductance on each of the three terminal pairs.

By using negative resistances in the network, the forward loss can be eliminated without decreasing the maximum reverse loss in the balanced condition. In fact, one can obtain negative loss or gain.

Method of Construction

Degree of balance of a circulator is dependent almost completely

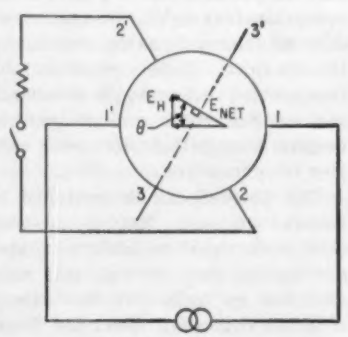

FIG. 3—Hall-effect circulator made by placing six contacts equally around the edge of a slice of semiconductor material

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"Been using Kester Flux-Core Solder for almost half a century, Tom; nothing like it."

"Kester Solder spools are always marked with the exact alloy, Joe; no code markings."

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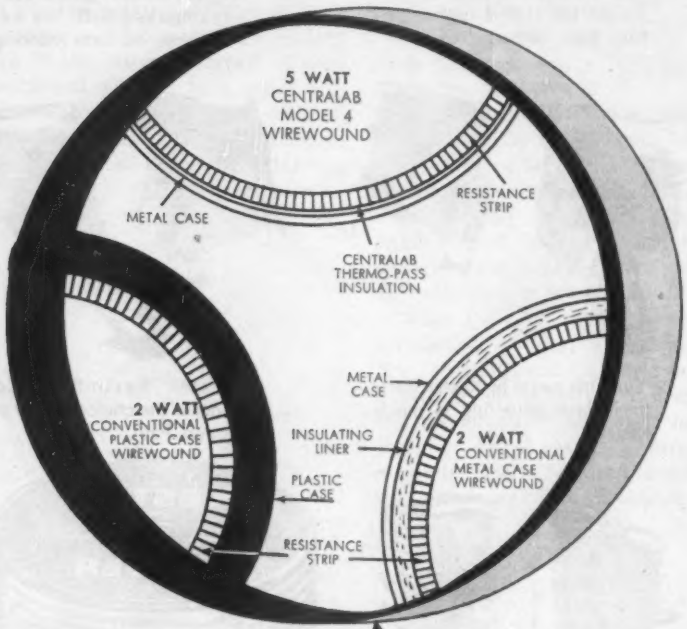
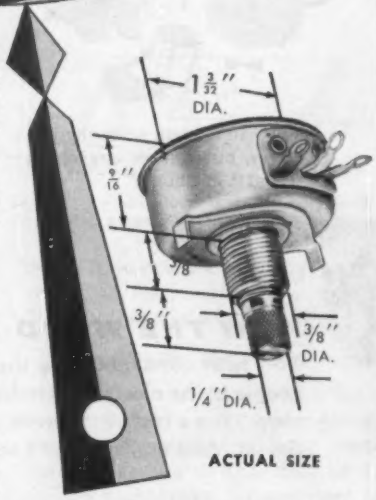


As you know, the rating and size of a variable resistor depends upon the speed with which heat can be transferred from the resistance element to the atmosphere. Centralab "thermo-pass" insulation combines exceptional heat transfer with a dielectric strength of 4500 volts per mil at 25° C. Result: Model 4 Radiohm, a conservatively rated 5 watt wirewound variable resistor smaller than a conventional 2 watt unit.

- Only 1 3/32" diameter by 9/16" deep.
- Resistance range, 1 ohm to 15K ohms; linear taper.
- 295° rotation, stop strength 15 inch pounds.
- Minimum life, 25,000 complete cycles.
- Totally enclosed elements.



ACTUAL SIZE

For detailed information write for Centralab Engineering Bulletin EP-493 or contact your Centralab sales representative. Ask your local distributor about the many values he carries in stock in the WW and WN series (listed in Catalog 30).

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upon geometric placement of the six terminals. Circulators made to date have been made from a single ingot of *n*-type germanium with resistivity of six to seven ohm-cm. Sample thicknesses have been 20 to 40 mils with diameters of about 0.125 in.

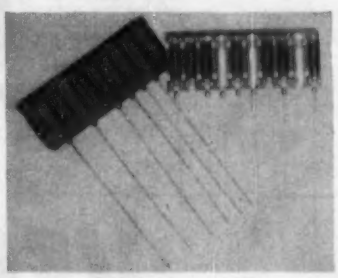
A first sample was made by thermo-compression bonding a gold wire to each of the six faces of an approximately hexagonal slab. Spacing of the terminals was so irregular that the results were very poor with no parallel network.

Subsequent circulators were made from samples cut with an ultrasonic cutter. These samples have six projections which can be electroplated with antimony-doped gold. This plating was then alloyed into the pips and small balled gold wires were thermo-compression bonded to the centers of the plated surfaces.

Practical Limitations

Assuming that external stray reactances can be made negligible by proper design and use of the circulator, speed of response will be limited only by the properties of the semiconductor material. All the circulator admittances are pure conductances and the loads should be pure conductances. Theoretically, the circulator should function properly over the entire frequency range from d-c up to the dielectric relaxation frequency of the material. This

Preassembled Parts



Manufacturers using point-to-point wiring methods can employ this new PAC (Pre-Assembled Components). Wire leads are mechanically crimped to individual component clips and then soldered. A variety of resistor-capacitor networks are available from the manufacturer—Erie Resistor Corp., Erie, Pa.

Standard Items or Custom Designs

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Whether specifications call for standard types of ceramic-metal bushings or specially designed assemblies for unusual applications, designers and electronics equipment manufacturers can rely on the uniform high quality and dependability of Alite ceramic-to-metal seals.

Vacuum-tight seals and bushings made of high alumina Alite are ideal for use in electronic applications where service conditions are extremely severe or critical. Alite has superior mechanical strength and thermal shock resistance. It maintains low-loss characteristics through a wide range of temperatures and frequencies. It resists corrosion, abrasion, and nuclear radiation. The extra-smooth, hard, high temperature glaze on Alite seals assures continuing high surface resistivity and dependable operation.

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Our ceramics specialists are anxious to assist you on problems involving ceramic-to-metal seals. Tell us about your specific requirements today.

New FREE Bulletins

Bulletin A-20 gives performance data and "inside look" at Alite facilities. Bulletin A-35 describes standard line of Alite High Voltage Bushings. Write for them today.

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1431

frequency is about a few kmc for the germanium used in the samples. Since sample geometry requires that all leads be fairly close to one another, radiation and pickup place a lower practical limit on the usable frequency range. Skin effect also becomes important at high frequencies.

Impedance levels from 200 to 600 ohms have been attained and this range should be extendable to 10 to 5,000 ohms still using only *n*-type germanium. With InAs and InSb, the low end of the range can be decreased to about 0.05 ohm, with the necessity for use of extremely low-resistance contacts.

Use of high-mobility materials such as InSb, InAs and HgSe permit use of smaller permanent magnets. But circulators made from these materials have extremely low impedance levels, on the order of one ohm, and are not useful in most circuits.

The semiconductor circulator has no junctions. Therefore, its lifetime depends only on the stability of the permanent magnet used. No special atmosphere is required for good operation. Contacts must be ohmic so that resistance will not vary with current level.

Crossed-Field Traveling-Wave Tube

HIGH POWER and high-frequency performance are characteristics of a new type of traveling-wave tube described by C. C. Johnson and C. K. Birdsall of General Electric at WESCON this year. The new tube, designated the M-J, is a crossed-field device in which the electron stream is not toward the slow-wave circuit, as in a M type, but parallel to the circuit.

Collector Electrode

The M-J circuit is placed in the plane of the usual end-hat of a linear or circular magnetron. A collector electrode is substituted for the usual circuit. During operation, the electron stream flows near the circuit and gives up energy to the circuit waves. But the electron stream is not collected on the circuit. Instead, it drifts toward a col-

Silicone rubber wire insulation withstands soldering heat without damage

Thanks to silicone rubber's remarkable heat resistance, no damage occurs when you lay a hot soldering iron on silicone-rubber-insulated wire. And silicone insulation strips cleanly and easily, saving hours of assembly time in the plant. Right-angle bends are no problem. Colors are bright for easy identification.

Long service life at 500°F Withstands 600°F and above for shorter periods. General Electric silicone rubber insulation meets military specifications MIL-W8777A, MIL-W16878B and others. When exposed to a direct flame, it forms a non-conducting ash of silicon-dioxide, releasing no toxic fumes, as do higher-priced insulating materials.

Will not cold flow Because silicone rubber is a *true* elastomer, it will not cold flow and subject wire to vibration, as will higher-priced insulating material. Newly developed stocks make possible thin-wall construction, have unusual abrasion resistance and physical strength. G-E silicone rubber stays flexible down to −75°F, special grades down to −150°F.

Greater reliability G-E silicone rubber exhibits excellent electrical properties and maintains them at both high and low temperatures, keeping its original dielectric strength for years. Moisture absorption is extremely low; ozone resistance approaches that of mica.

General Electric silicone rubber insulation matches or exceeds the vital properties of insulation costing three times as much. Find out what it can do for you. Mail coupon for technical data.

GENERAL ELECTRIC

Silicone Products Department — Waterford, New York

Section R8CC10, Silicone Products Dept.
General Electric Company, Waterford, N. Y.

Please send me more information on wire insulated with G-E silicone rubber.

Name_____ **Position**_____

Company_____

Address_____

City_____ **Zone**_____ **State**_____

20—NEWS-POST Baltimore, Fri., Aug. 1, 1958

Westinghouse Awarded $22 Million Navy Contract

The company's Friendship Airport plant will produce shipboard radio transmitters and radar equipment which it designed.

The radar particularly is considered a revolutionary breakthrough in electronics, permitting results identical to that achieved by conventional radar with 30 times the power.

R. E. KIRBY, manager of the electronic division, said there are actually three contracts involved.

One worth more than $8 million is for production of the advanced air-search radar. It is to be used on carriers, cruisers and other ships.

The second contract is for $1 million worth of conventional design radar.

The largest contract, more than $12 million, is for production of medium and high frequency communications transmitters. These would be used on surface ships and submarines.

"The new radar equipment," Kirby said, "employs a revolutionary electronic circuit technique considered a technological breakthrough in the evolution of shipboard air-search radar." It was designed and tested here.

The transmitter is the product of Westinghouse research begun in 1951.

This Navy contract is the result of another major technological breakthrough by our outstanding team of engineers, at Westinghouse–Baltimore. An exciting opportunity exists for qualified engineers to join this team. You will be a part of our wide range new development program which will result in a continuing pattern of major breakthroughs in the future.

PARTIAL LIST OF CURRENT OPENINGS:

Digital-Analogue Computer Design
Transistor Circuitry
UHF Communications
Servo Control Loops
Electronics Circuitry
Intermediate Frequency Amplifiers
Microwave Components
Network Synthesis

TO APPLY: Send a resume of your education and experience to Dr. J. A. Medwin, Dept. 823, Westinghouse Electric Corporation, P. O. Box 746, Baltimore 3, Maryland.

Reprinted from the BALTIMORE NEWS POST

Westinghouse – BALTIMORE

YOU CAN BE SURE... IF IT'S Westinghouse

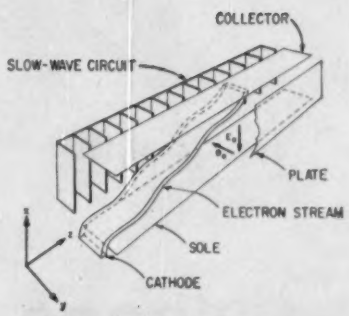


FIG. 1—Basic M-J configuration. The electron stream in flowing parallel to a slow-wave circuit in a region of crossed electric and magnetic fields gives up energy and drifts toward the collector electrode at upper right

lector which can be made to dissipate considerable power.

Figure 1 shows a linear M-J tube with an injected stream. The electron stream interacts with the circuit waves and is deflected as shown. The transverse r-f electric field, along B_o, causes the beam to snake along B_o. The stream moves closest to the circuit in a retarding electric field if the average stream velocity E_o/B_o is made larger than that of the wave. In this case, there is a net loss of energy from the stream and a consequent gain of energy by the circuit waves. Those electrons giving up energy move to a region of higher potential and maintain their longitudinal velocity.

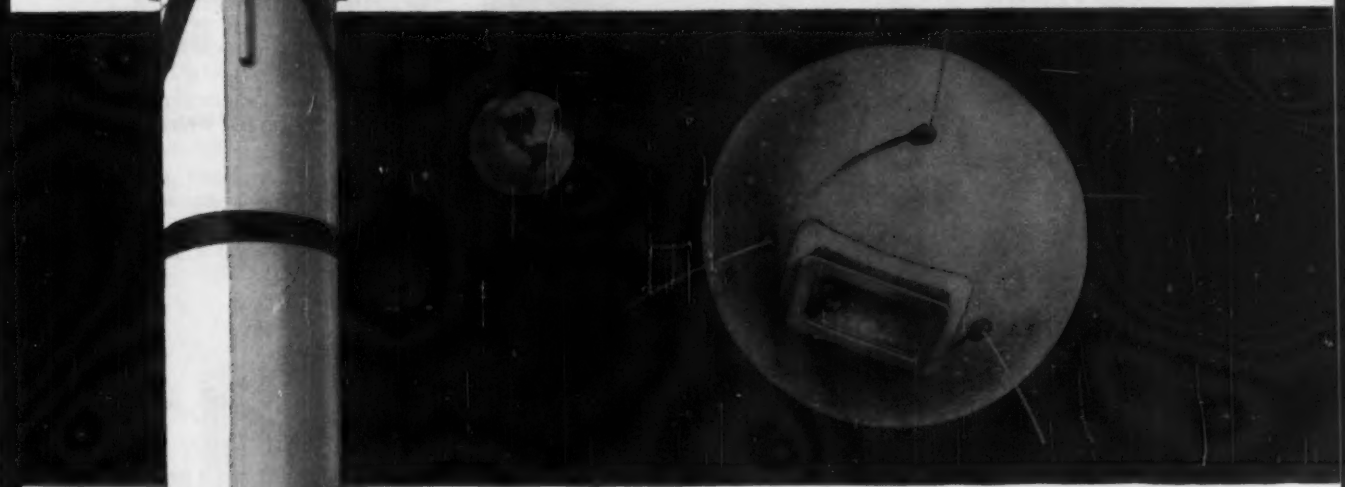
Two main advantages of the tube are the use of a separate collector to dissipate larger quantities of heat than the circuit itself can and a uniform rate of gain over the tube length. A limiting factor for the tube is that it is necessary to obtain a uniform beam velocity. This requirement necessitates a constant E_o in the beam region.

Two experimental tubes have been built. The first was a demountable device which used a flattened helix slow-wave circuit. It produced about seven db net forward gain at 700 mc. The second was constructed as an M-J backward-wave oscillator. It produced about 10 mw output power at 4.5 kmc.

Rotary Wafer Switch Maintains Easily

INDIVIDUAL SWITCH WAFERS, including rotary sections, are instantly

New Product Announcement



STEMCO TYPE MX* THERMOSTATS

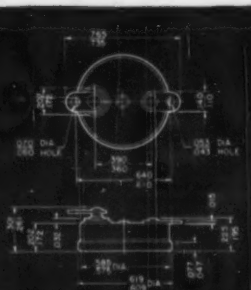
especially designed for missile, avionic and electronic applications

New Stemco Type MX Thermostats are miniature snap-acting units designed to *open* on a temperature rise. Being compact, lightweight units able to withstand high G's under wide ambient temperature ranges, Type MX thermostats are ideal for missile, avionic and other electronic applications where close temperature control is mandatory.

Basic design flexibility of the Stemco Type MX Series means the units can be supplied from regular production runs in a wide variety of models, both semi-enclosed or hermetically sealed. Ceramic or metal bases for semi-enclosed units, round enclosures or CR-7 crystal cans for hermetically sealed units. Several types of terminal arrangements, mounting provisions, brackets, etc., are available.

Stemco Type MX thermostats give you performance . . . small cubage . . . rugged reliability . . . *at a production price.*

*** 2° to 6°F differentials available**



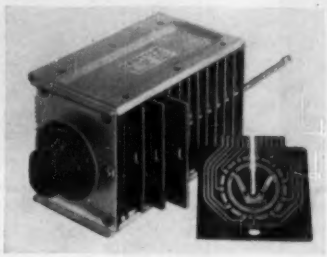
AA-7200

STEVENS *manufacturing company, inc.*
Mansfield, Ohio

STEMCO ®
THERMOSTATS

CIRCLE 89 READERS SERVICE CARD

removable without unsoldering or disassembling from a new rotary wafer switch. The switch, developed by Tabet Manufacturing Co., Inc., of Norfolk, Va., incorporates printed-circuit wafers which plug into semi-floating printed-circuit receptacles. Silver-plated contact surfaces are used for manual versions of the switch and rhodium plating for motor-driven high-speed models.



Typical communications switch illustrates simple method for inserting rotary-switch wafers. Removed wafer is at right

Contacts are arranged radially on both sides of phenolic wafers. The contacts are positioned so that an active contact segment on one side is directly opposite an inactive segment on the reverse side. Active and inactive segments are symmetrical in relation to the off position. This design technique allows wafers to be inserted into the switch assembly without regard to which face of the wafer is right-hand or left-hand.

Double Rotary Arm

Circuits through the contact segments are made by a double rotary arm. Contacts of the arm are staggered by the width of a wafer segment. The operator can make and break a single circuit alternately on one side of the switch wafer and then on the opposite side.

When the switch is in the off position, a slot in the rotary mechanism is aligned with a slot in the wafer. As a result, any wafer can be withdrawn without otherwise disconnecting or dismantling the switch assembly. Framework of the switch holds the wafers in proper alignment by slots or grooves into which the wafers are inserted and locked into place.

ADC has completed design and tooling on a line of transformers which are electrically and physically interchangeable with components made by the Western Electric Company. This provides a quality source for those affected by Western Electric's announcement that they would no longer supply these items to manufacturers. Included in the ADC line are the oval can types popular in the 120 repeat coil series.

In addition to their regular stock, and custom transformers for the electronic industry, ADC has long been a dependable source of telephone-type transformers and coils. If you need iron core components which are interchangeable with Western Electric, check ADC. You'll be pleased with both price and delivery.

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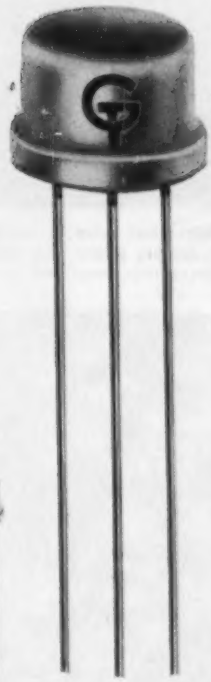
NEW HIGH VOLTAGE NPN TRANSISTORS ALLOW TUBE REPLACEMENT AND CIRCUIT COMPATIBILITY



ACTUAL SIZE

GT's new high voltage germanium alloyed junction transistors now allow the same optimization as formerly could be realized only with vacuum tubes. These characteristics plus conventional "transistor" advantages offer new design opportunities in computers, magnetic memory cores, data processing equipment, gas filled indicator tubes and other applications where reduction of space, weight and high reliability are prime requisites.

The GT 1200 is particularly suited to drive gas filled display tubes, such as the Burroughs Nixie ® and Pixie ®, without changing existing circuitry other than altering voltages so as not to exceed the rating of the transistor.

		GT 1200
Collector to Base Voltage (Emitter Open)	$I_C = 25\ \mu A$	90 Volts Min.
Emitter to Base Voltage (Collector Open)	$I_E = 25\ \mu A$	20 Volts Min.
Collector to Emitter Voltage (Punch Through)	$I_E = 25\ \mu A$	90 Volts Min.

Supplied in TO-9 case

GT 1201 — GT 1202, in addition to driving gas filled display tubes, are ideally suited for driving high inductance loads, driving transformer coupled loads and allow more nearly perfect impedance matching. These transistors are fast devices capable of handling high impedance loads and large signal swings.

		GT 1201	GT 1202
Collector to Base Voltage (Emitter Open)	$I_C = 25\ \mu A$	75 Volts Min.	45 Volts Min.
Emitter to Base Voltage (Collector Open)	$I_E = 25\ \mu A$	20 Volts Min.	20 Volts Min.
Collector to Emitter Voltage (Punch Through)	$I_E = 25\ \mu A$	75 Volts Min.	20 Volts Min.

Supplied in TO-9 case

Write today for Bulletin GT 1200

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GN

Wire Pails Cut Winding Costs

Inner and outer pail extensions guide wire into cone of dereeler

This setup supplies 300 feet of wire per minute to 2-pole motor winder

PAIL PACKAGES of magnet wire reduce costs of manufacturing fractional horsepower motor field windings, according to Fasco Industries, Inc., Rochester, N. Y. The company uses 5-gallon pails containing 100 pounds of 25 to 31-gage wire insulated with Formvar, Nylon and other materials.

The pails are reported to hold 10 times more wire than spools. This reduces downtime required to change winding machine supplies. Rejects of stators wound from 2, 4 or 6 supplies is also reduced, since the supplies last longer. Normally when a supply runs out while a stator is being wound, the stator must be rejected and the wire left in other supplies discarded.

Pails are made of 26-gage steel by Jones & Laughlin Steel Corp. Container Division. The wire is layered around a vertical cylindrical fiberboard core as the pail is filled. Empty pails are discarded or used as waste buckets or tote cans. The pails are used with dereelers which can take out the wire at speeds up to 2,700 feet a minute. Damage to insulation is prevented by a smooth finish in the pails.

Liquid Plastic Laminates Glass Parts

GLASS LAMINATING method devised by Corning Glass Works for its twin panel for tv picture tubes may also be used to create shock-absorbing designs for other glass-housed components.

Pieces to be laminated need not be perfectly matched so long as there is a closure around the space between the two parts. The laminating material will cure without pressure and high temperature.

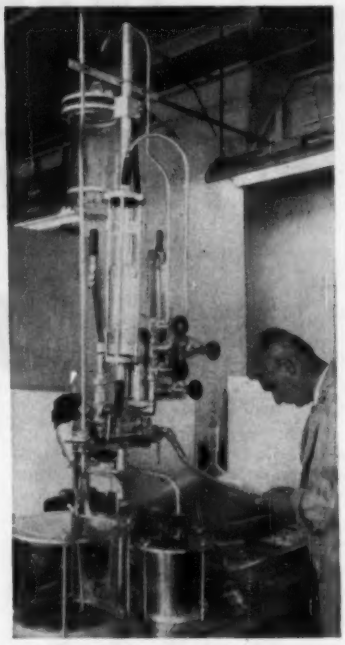
Purpose of the twin panel design is to eliminate protective glass plates on tv sets. The skirt of the contoured panel fits around the regular 90 or 110-degree tube envelope. The panel is 0.225 inches thick and is made of glass identical to the tube face.

Laminating material is a liquid plastic which can be tinted to desired transmission levels. It is nontoxic, noncontaminating and will withstand temperature fluctuations of −40 F to 160 F. Plastics in use are an acrylic resin, Duraplex TV-10, developed by Rohm & Haas Co., and an epoxy resin, DER 741 with DEH 61, developed by Dow Chemical Co. Both have a refractive index identical to glass used.

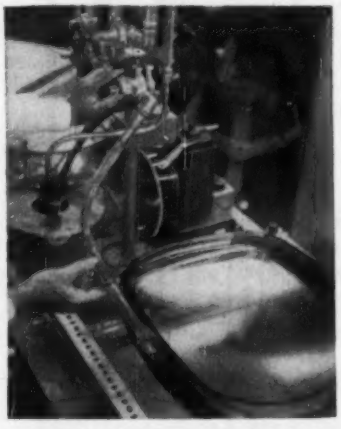
Before assembly, the twin-panel and tube face are washed with a 5 percent solution of trisodium phosphate, rinsed with a 5 percent solution of sulphuric acid and dried with filtered air. Any other good degreasing, oxidizing wash may be used.

The twin panel is placed face down on a table. Four flexible spacers 0.70 inches thick are placed at the twin panel corners. The tube is placed face down on the spacers. The spacers are invisible in the plastic since index of refraction is identical.

The casting resin is mixed with



Pilot plant setup at Rohm & Haas for preparing plastic and filling space between twin panel and tv tube



Tube has been cut away to show filling procedure

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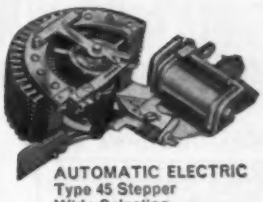

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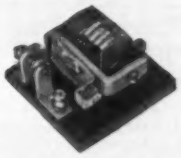

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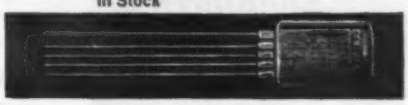

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Sub Miniature Hermetically Sealed Relay. All Advance Types in Stock.

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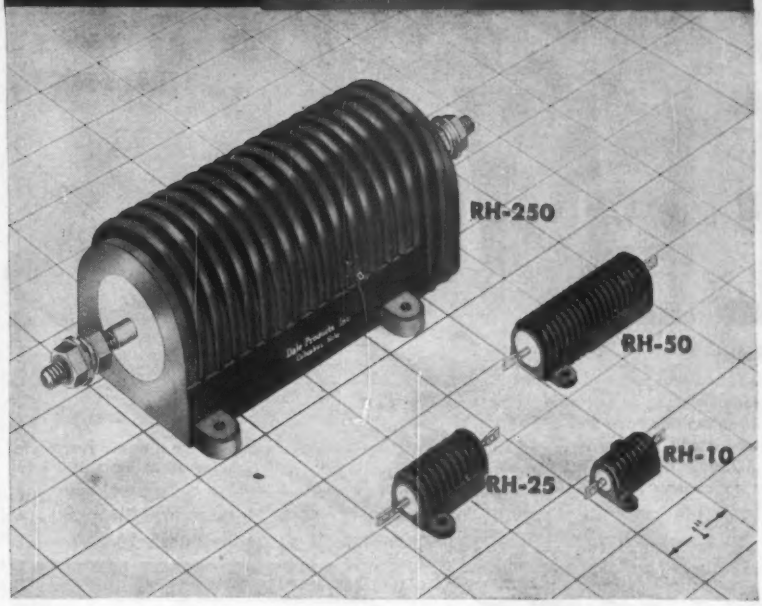
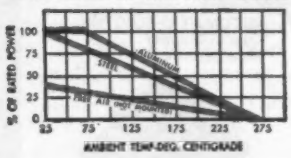


TYPE RH POWER RESISTORS

Wire Wound, Precision, Miniature, Ruggedized

TYPICAL DERATING CURVE



JUST ASK US

The DALOHM line includes precision resistors and trimmer potentiometers (wire wound and deposited carbon); resistor networks; collet fitting knobs and hysteresis motors designed specifically for advanced electronic circuitry.

If none of the DALOHM standard line meets your need, our engineering department is ready to help solve your problem in the realm of development, engineering, design and production.

Just outline your specific situation.

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Designed for the specific application of high power requirements, coupled with precision tolerance. Mounts on chassis for maximum heat dissipation. Operates under severe environmental conditions as outlined in specifications below.

- Rated at 10, 25, 50 and 250 watts.
- Resistance range from 0.1 ohm to 175K ohms, depending on type.
- Tolerance 0.05%, 0.1%, 0.25%, 0.5%, 1%, 3%.

TEMPERATURE COEFFICIENT: Within ±0.00002/degree C.

COMPLETE PROTECTION: 100% impervious to moisture and salt spray.

WELDED CONSTRUCTION: Complete welded construction from terminal to terminal.

RUGGED HOUSING: Sealed in silicone, inserted in radiator finned aluminum housing.

MINIATURE SIZE: 7/16 x ¾ to 3 x 4-½ inches.

MILITARY SPECIFICATIONS: Surpasses applicable paragraphs.

Picture tube is fitted inside panel

After cure, plastic has formed permanent seal between tube and panel

its catalyst and degassed. Degassed resin is fed into the space between the tube and panel by a delivery nozzle until the space is completely filled. The plastic is given a brief cure. The spacers yield to allow for plastic shrinkage.

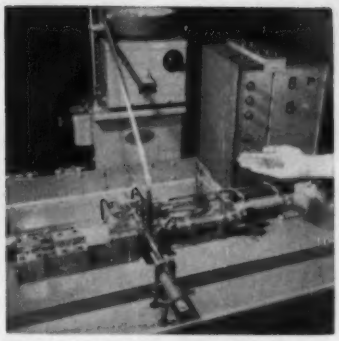
The method, according to Corning, results in a tube face that is permanently clean. It cannot be imploded by a normal breakage source and is shatterproof should an implosion be caused by high impact.

Machine Welds Part Pigtails

ASSEMBLY and welding machine produces pigtail assemblies for conventional resistors, capacitors, diodes and rectifiers. Production rate, according to Raytheon Mfg. Co., Waltham, Mass., is 3,000 an hour.

Lead wire is fed from a reel to welding position, straightened, and cut to length by a guillotine cut-off. Cups are fed from a vibratory hopper to welding position. Welding is controlled by a heat program timer. Assemblies are ejected into a box.

The machine will handle cups of

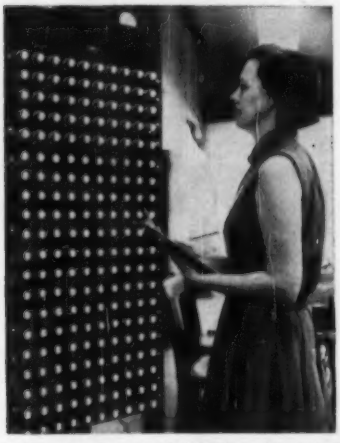


Wire fed from left, cups from hopper meet at welding station in center

different sizes and wire in sizes from 0.025 to 0.050 inch. Operation can be one-shot or repetitive. Fail safe devices can be added to halt operation when materials run out.

Readout Tube's Parts Are Stacked Vertically

CATHODES AND ANODES etched from foil and stacked on support posts make up the active elements of gas-filled, cold-cathode Nixie readout tubes manufactured by Burroughs Corp. Electronic Tube Division, Plainfield, N. J.



Tubes count some 10,000 times in aging

Each tube contains 10 characters (cathodes) and a common anode screen grid. These are etched by vendors in foil 3 to 5 mils thick. Stroke width of miniature tube numbers is about 5 mils. Gas glow makes them appear larger.

Before being cut apart with snippers, frames of cathodes and anodes are chemically and ultrasonically

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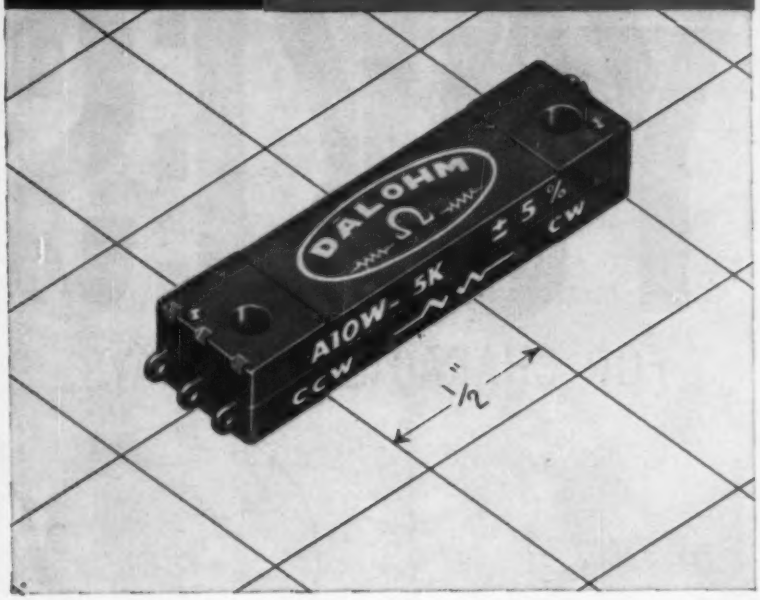


TYPE A10-W TRIMMER POTENTIOMETERS

Wire Wound, Precision, Sub-Miniature, Ruggedized

A10-W Trimmer Potentiometers are completely sealed for high temperature operation; with ruggedized construction, they provide reliability under the most severe operating conditions. Four designs available for the demanding space requirements of precision circuitry.

- Rated at 1 watt up to 70° C. ambient temp.
- Resistance range from 1 ohm to 30K ohms.
- Standard tolerance: ± 5%, closer tolerance available.

RESOLUTION: .1% to 1%, depending on resistance.

OPERATING TEMPERATURE RANGE: −55° C. to 150° C.

INSULATION RESISTANCE: 1000 megohm minimum at 500 VDC at room temp.

END RESISTANCE: Not greater than 4%.

TEMPERATURE COEFFICIENT OF TRIMMER UNIT: Within ± 100 parts per million.

SUB-MINIATURE SIZE: .220 X .312 X 1.250 inches.

SCREW ADJUSTMENT: Fully adjustable throughout 25 turn range.

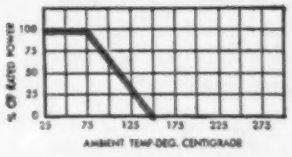
SHAFT TORQUE: 7 inch/ounce maximum.

SAFETY CLUTCH: Clutch arrangement on movable wiper contact prevents breakage due to over-excursion.

SELF-LOCKING ADJUSTMENT: Wiper will not shift under severe vibration or shock.

MILITARY SPECIFICATIONS: Surpasses applicable paragraphs.

TYPICAL DERATING CURVE



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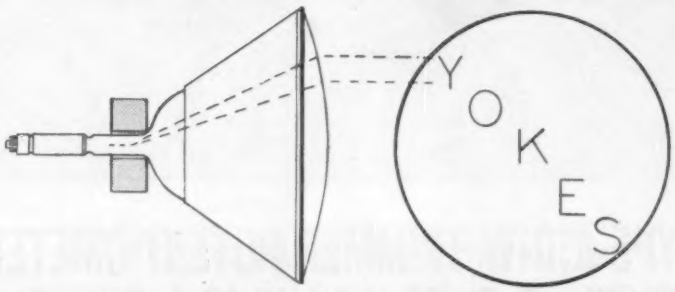
YOKES

FOR CHARACTER DISPLAYS



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cleaned. Ultrasonic cleaning was found to assist in removing surface gases from the metal.

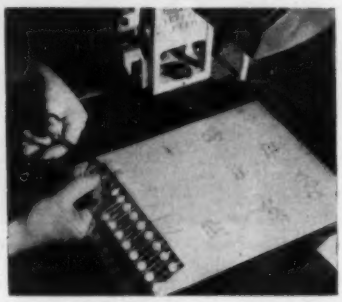
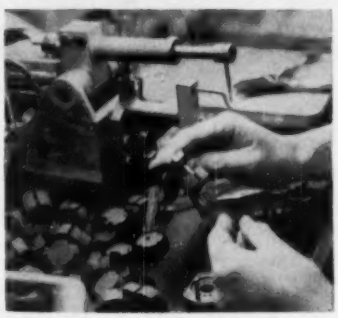
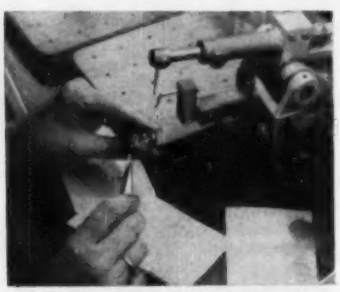


Photo-etched characters are cut from protective frames



Support posts and cups are assembled on 13-pin stem



After characters are stacked projecting tabs are bent to pins and welded

Support posts and anode cups are welded together on a 13-pin stem to form the assembly base. In a prior operation, the posts are glazed for insulation. Posts are inserted in glass tubing which is flame-fuzed.

Cathodes are assembled on the posts alternately with glass ring spacers. Cathode tabs are bent to stem pins and welded. Tops of posts are crimped off and the anode screen welded in place.

After sealing, exhaust and gas filling, tubes are stabilized in aging racks, where they are stepped through a counting sequence to

More materials: Rugged, versatile compositions to resist impact, stress, vibration, pressure, heat, thermal shock, wear, chemical reactions. Superior electrical characteristics for higher temperatures and frequencies.

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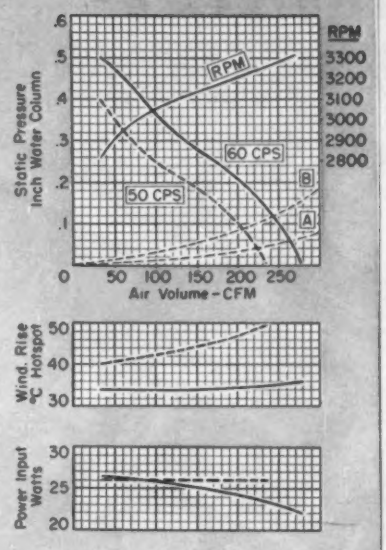
SAUCER FAN

The Saucer Fan represents an entirely new design concept whereby the driving motor is built within the propeller hub limiting its axial length to the minimum measurement required by a highly efficient motor. Ideally suited for tightly packed electronic packages, where space is critical, the Saucer Fan will provide cooling air to the amount of 280 cfm. Power requirement is 115 vac. 50-60 cps, 1 0.

The fan's pressure performance is tailored to the requirements of a modern, washable dustfilter. "Servo type" mounting flanges at each end of the venturi ring permit simplicity of mounting without loss of space. Direction of airflow may be easily reversed by turning the fan end for end. Electrical connections are made to a compact terminal block.

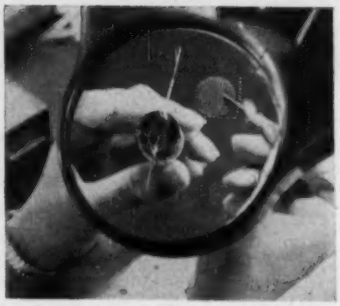


For complete technical details write to . . .

ROTRON

ROTRON MANUFACTURING COMPANY, INC.

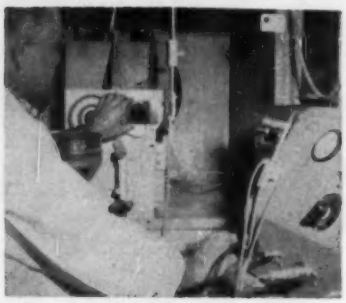
WOODSTOCK, NEW YORK In Canada: The Hoover Co., Ltd., Hamilton, Ont.



Placing anode screen on top of stack completes mount assembly

count some 10,000 times. A beam switching tube drives the circuit. Inspections are made after mount assembly and before and after aging. Characteristics of the glow produced by application of a Tesla coil indicate whether the tube has been properly filled with gas.

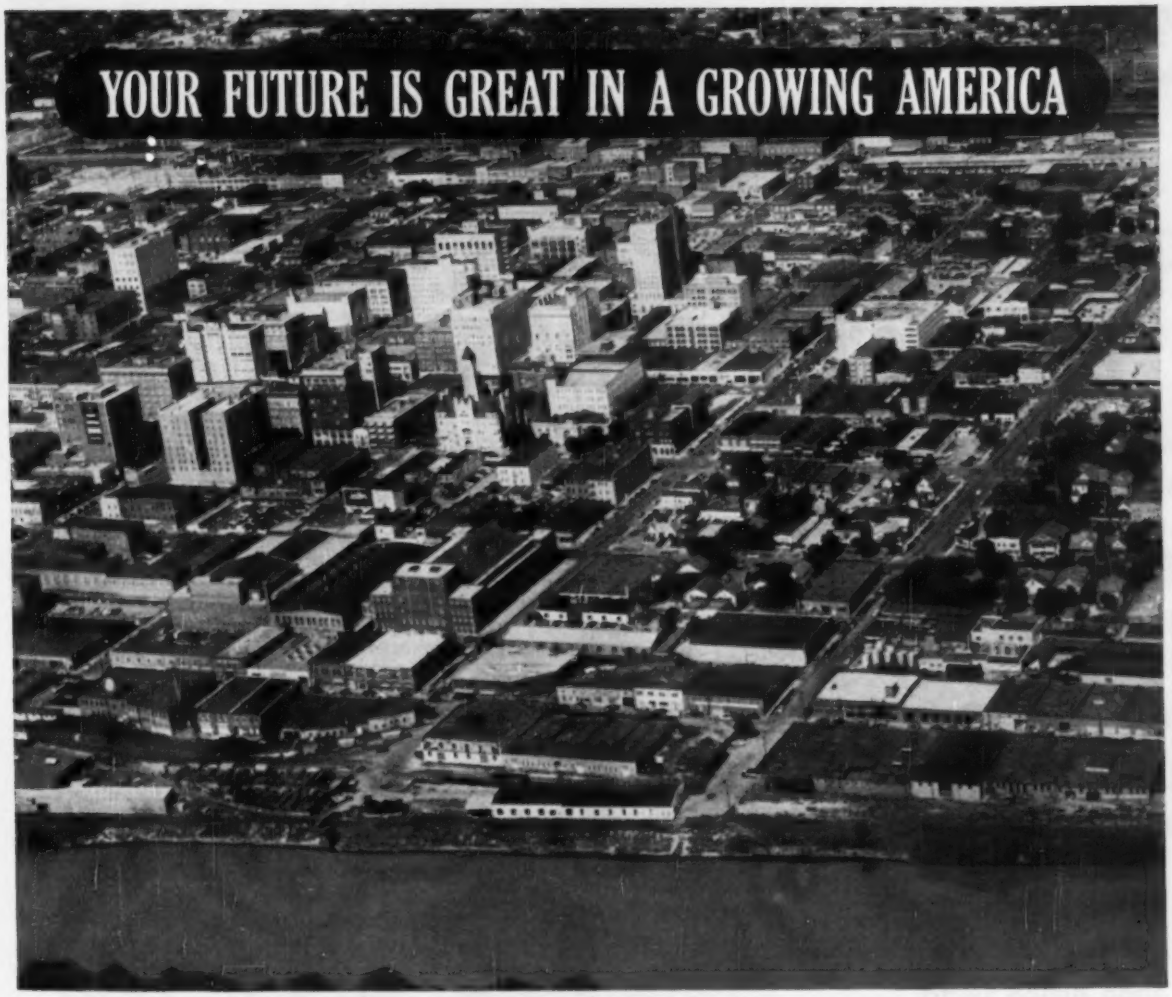
Bicarbonate Strips Winding Insulation



CONTROLLED STRIPPING of organic potentiometer winding coatings is accomplished at the Gamewell Co., Newton Upper Falls, Mass., by a machine which propels abrasive dust in an inert gas stream.

The abrasive is sodium bicarbonate, which removes the coating without damage to the wire contact wiping surface. The particles hit the coating at a speed of 1,100 feet a second. Stripping time averages 30 seconds compared with 1 to 1.5 minutes by hand buffing, the company says.

Photo shows setup used to strip contact areas on sine-cosine potentiometer winding. Card is held in fixture which revolves before dust nozzle. Machine is manufactured by S. S. White Industrial Division, New York, N. Y.



THE CITY THAT DIDN'T EXIST A MONTH AGO

Every 30 days the U. S. adds as many new Americans as live in Norfolk, Va.—creating brand-new wants and needs which must be satisfied.

What does this mean to you? It means greater opportunities than ever before—in all fields. Home construction is expected to double by 1975. Power companies plan to increase output 250% in the next 20 years to provide the power for scores of new labor-saving devices. Clothing suppliers predict a one-third increase in 7 years.

With 11,000 new citizen-consumers born every day, there's a new wave of opportunity coming.

7 BIG REASONS FOR CONFIDENCE IN AMERICA'S FUTURE

1. **More people** . . . Four million babies yearly. U. S. population has *doubled* in last 50 years! And our prosperity curve has always followed our population curve.
2. **More jobs** . . . Though employment in some areas has fallen off, there are *15 million* more jobs than in 1939—and there will be *22 million more* in 1975 than today.
3. **More income** . . . Family income after taxes is at an all-time high of $5300—is expected to pass $7000 by 1975.
4. **More production** . . . U. S. production *doubles* every 20 years. We will require millions more people to make, sell and distribute our products.
5. **More savings** . . . Individual savings are at highest level ever—*$340 billion*—a record amount available for spending.
6. **More research** . . . *$10 billion* spent each year will pay off in more jobs, better living, whole new industries.
7. **More needs** . . . In the next few years we will need *$500 billion* worth of schools, highways, homes, durable equipment. Meeting these needs will create new opportunities for everyone.

Add them up and you have the makings of another big upswing. Wise planners, builders and buyers will act *now* to get ready for it.

FREE! Send for this new 24-page illustrated booklet, "Your Great Future in a Growing America." Every American should know these facts. Drop a card today to: ADVERTISING COUNCIL, Box 10, Midtown Station, New York 18, N. Y.

(This space contributed as a public service by this magazine.)

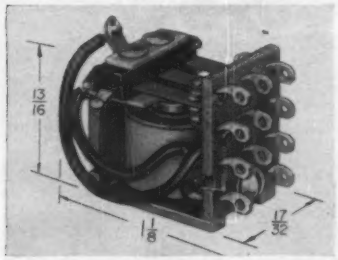
NEW PRODUCTS

Servo Motor
400 cycle

MECHATROL, a division of Servomechanisms, Inc., 1200 Prospect Ave., Westbury, L. I., N. Y., announces a 400 cycle servo motor in BuOrd size 5, weighing only 0.85 oz and said to be shorter than those presently available in this diameter. The 5S1-3 operates at 26 v, fixed phase and 40 v center-tapped control phase, power input 2 w per phase, with a nominal no load speed of 11,000 rpm, and 42,000 radians per sec² theoretical acceleration. Starting voltage is only 0.6 v maximum. Stall torque is 0.1 oz-in. minimum. Maximum power output is 0.3 w at a speed of 6,000 rpm. Operating temperature is −55 C to +85 C. **Circle 300 on Reader Service Card.**

Remote Amplifier
versatile unit

GATES RADIO CO., Quincy, Ill., announces the Unimote, a single channel remote amplifier. It will perform equally well as a microphone preamplifier, program amplifier up to ±18 dbm output, repeater amplifier, isolation amplifier and as a standby amplifier for quick connection to an emergency circuit. Printed wiring is employed throughout. Size is 11 in. wide, 5¾ in. high and 5 in. deep. **Circle 301 on Reader Service Card.**

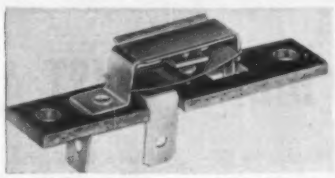


Subminiature Relay
weighs 5/8 oz

POTTER & BRUMFIELD, INC., Princeton, Ind., announces a subminiature armature type relay for commercial and industrial applications. The KM relay operates on as little as 750 mw. It provides switching arrangements up to 3 pdt; it switches up to 2 amperes at 115 v 60 cycle, resistive loads, and provides over a million operations at rated load. A d-c operated relay, it can be furnished for voltages up to 48 v. Some present applications include automatic traffic control systems and automatic weather stations. **Circle 302 on Reader Service Card.**

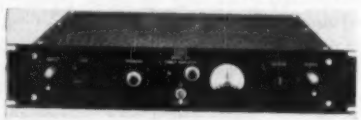
Snap Action Switch
low cost device

CHERRY ELECTRICAL PRODUCTS CORP., 1650 Deerfield Rd., Highland Park, Ill. The S75-00A switch features a low, flat actuator ideally suited for pushbutton, cam or interlock applications. Built-in positive stop limits overtravel and prevents damage to the switch mechanism. The over center "bowed" blade provides high contact pressures and fast contact transfer with a life expectancy in the hundreds of thousands. Normally open version of the switch is priced at 17.2 cents each in 10,000 piece quantities. **Circle 303 on Reader Service Card.**



D-C Amplifier
rack-mounted

SOUTHWESTERN INDUSTRIAL ELECTRONICS CO., 2831 Post Oak Road, Houston 19, Texas. Model B-1 rack-mounted d-c amplifier delivers up to 6 w at an output impedance of less than 0.1 ohm over the frequency range from d-c to 20,000 cps. Transistorized, direct-coupled circuitry not only makes it compact, but eliminates warmup time to provide instant, full-power stability. **Circle 304 on Reader Service Card.**

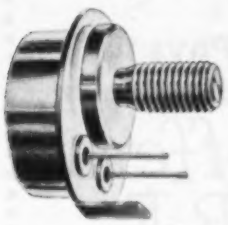


Converter
rms to d-c

SYSTRON CORP., 2000 Concord Blvd., Concord, Calif., announces a precision rms to d-c converter for industrial or lab measurement of a-c voltages. Model 1240 features a true rms conversion accuracy of ±0.1 percent, with high input impedance, 0.5 sec time response, 50 cps to 10,000 cps frequency re-

WESTINGHOUSE TAKES A GIANT STEP IN SILICON POWER TRANSISTORS

Through major improvements in silicon purification and transistor fabrication, Westinghouse has broken down the previous limitations of Silicon Power Transistors. The result is a new series of Westinghouse Power Transistors which can operate at high efficiencies in the "true power range."



LIFE-SIZE DRAWING shows how Westinghouse Silicon Power Transistor is designed for attachment to heat sink with a screw stud. All leads are in the base.

	CURRENT RATING	V_{CBO}	V_{CE} (V_{EB}=0)	R_S
WX1015	2 AMPERES	30-300V	30-300V	0.5 OHMS TYPICAL
WX1016	5 AMPERES	30-300V	30-300V	0.4 OHMS TYPICAL

Thermal resistance—Junction to case, 0.7°C/watt typical. Current ratings based on the current at which current gain is equal to or greater than 10. It is possible to switch higher collector currents with some sacrifice in gain.

These are the first members of an entirely new family of Westinghouse Silicon Power Transistors, which have the advantages associated with silicon (high voltages and high operating temperature) without the disadvantages (high losses). As you can see from the chart below, these units possess exceptionally low saturation resistance—less than one half ohm. This low saturation resistance results in low internal dissipation. Coupled with high power handling capacity, it makes possible silicon transistors which can efficiently handle 1000 or 1500 watts. For example, as a DC switch, handling 1.5 kw (300 volts at 5 amperes) the internal dissipation of the units is about 12.5 watts with a resulting efficiency of better than 99%.

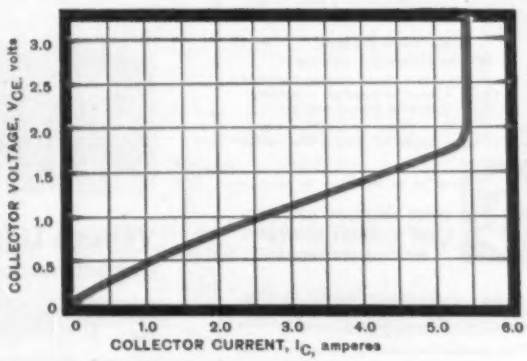
Like other silicon devices, these transistors can operate in ambient temperatures up to and exceeding 150°C while germanium units are limited to 85°C. Thus, where the higher power rating is not required these units may be used for their high temperature capabilities. It also follows that wherever germanium power units are presently employed, a switch to silicon transistors will result in higher reliability of operation, because of the greater margin of safety with respect to operating temperature.

There are a great many circuits for which this new type of silicon power transistor is made to order. It will find use in inverters or converters (AC to AC, AC to DC, DC to AC, DC to DC), to control frequencies for data processing, servo output, and other aircraft information applications. It will serve as a low frequency switch, as mentioned above; it will operate efficiently with low power supply voltages; and it will find a number of uses in class A amplifiers. There are also many additional applications—too numerous to list here.

These Westinghouse Silicon Power Transistors are available in sample quantities for your testing and immediate application. Call your Westinghouse representative or write directly to Westinghouse Electric Corporation, Semiconductor Dept., Youngwood, Penna.

YOU CAN BE SURE...IF IT'S

Westinghouse



LOW SATURATION RESISTANCE is exhibited in this graph showing values for a typical Westinghouse Silicon Power Transistor driven to 5 amperes. The values are fractions of those observed in other silicon transistors.

Looking for the right resistor?

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...along with everything you'll want to know about the complete standard line of Speer Resistor Products – specifications, characteristics and applications:

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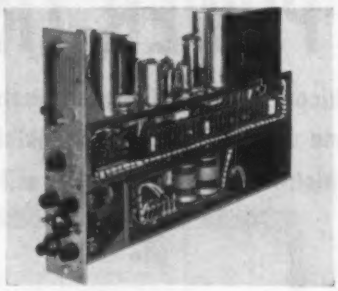
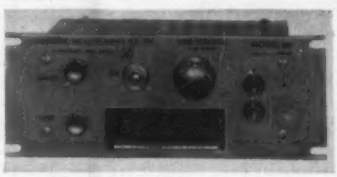
CIRCLE 206 READERS SERVICE CARD

sponse, and long term stability for a-c inputs regardless of wave form. It is available for production testing with full scale ranges of 0.1, 0.3, 1, 3, 10, 30, 100, and 300 selected by one control. Output for each full scale is either 3 or 10 v d-c with less than 10 ohms output impedance. **Circle 305 on Reader Service Card.**



D-C Amplifier high current output

DYNAMICS INSTRUMENTATION CO., 1118 Mission St., South Pasadena, Calif. Model 1411 d-c amplifier for driving recording galvanometers features high-current output (±100 ma) up to 30 kc, electrical offset control, output metering, damping resistance selector, dummy loads with substitution by relay, and continuously variable voltage gains from 1.0 to 3,000. Standard specifications include 100 K input impedance, ± 2 μv drift limits, and less than 0.1 percent nonlinearity for the usual galvanometer frequency range. **Circle 306 on Reader Service Card.**



Voltage Limiter instantaneous

ELECTRONIC MEASUREMENTS CO., INC., Eatontown, N. J., has developed an instantaneous, all electronic voltage limiter for use with power supplies. It is used to protect transistors, and other voltage

Why do it Yourself?

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Jeffers R.F.

Choke Coils

You can save time, labor, and money by stocking the wide range of Jeffers R.F. choke coils just as you do resistors, capacitors, and other similar components. You can forget tedious, expensive hand assembly from miscellaneous forms, wires, and coatings by using standardized Jeffers coils, completely assembled for use.

Jeffers coils are well made, using insulated copper wire windings... husky molded jackets. All windings are soldered to leads... shorted end turns are completely eliminated.

Put these advantages to work in your circuits! Jeffers Electronics offers you . . . ready for delivery . . . a complete line of R.F. choke coils with a complete range of inductance values. Write today for our specification sheets.

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CIRCLE 207 READERS SERVICE CARD

sensitive devices, from damage due to both low- and high-speed voltage excursions. The limiter is adjustable to provide protection at any voltage between 0 and 50 v, and it will handle power supplies with ratings up to 3 amperes. **Circle 307 on Reader Service Card.**

V-R Power Supply transistorized

KEPCO LABORATORIES, INC., 131-38 Sanford Ave., Flushing 55, N. Y. Model SC-150-1 transistorized v-r power supply delivers 0-150 v, 0-1 ampere. Regulation for line or load is less than 0.01 percent or 0.002 v, whichever is greater. Ripple is less than 1 mv rms. Recovery time is less than 50 μsec. Stability for 8 hours is less than 0.01 percent, or 0.002 v, whichever is greater. Operating ambient temperature is 50 C maximum. Temperature coefficient is less than 0.01 percent per deg C. Output impedance is less than 0.05 ohm. **Circle 308 on Reader Service Card.**

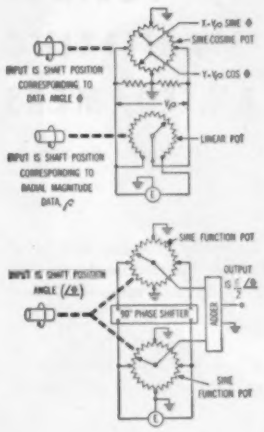
Voltmeter 10 cps-1,000 kc

THE DAVEN CO., Livingston, N. J. Model 21A electronic voltmeter measures a-c voltages over a range of 10 cps to 1,000 kc. It will also serve as a null indicator, as a power

SINE-COSINE
Precision
POTENTIOMETER-RESISTORS

For resolution of voltage into sine and cosine components in accordance with positions of shaft rotation.

TYPICAL APPLICATIONS:


INPUT IS SHAFT POSITION CORRESPONDING TO DATA ANGLE Φ
INPUT IS SHAFT POSITION CORRESPONDING TO RADIAL MAGNITUDE DATA ρ
LINEAR POT
INPUT IS SHAFT POSITION ANGLE (Δθ)
90° PHASE SHIFTER
ADDER
OUTPUT
SINE FUNCTION POT

ANGLE DATA TRANSMISSION as used in automatic controls, directional and ranging systems, analog computers, and telemetry.

PHASE DIVISION as used in investigation of phase sensitive systems, delay measurements, and timing applications.

DATA CONVERSION as used in rotation of coordinates, or conversion from polar to rectangular coordinate form, for computers or data display applications.

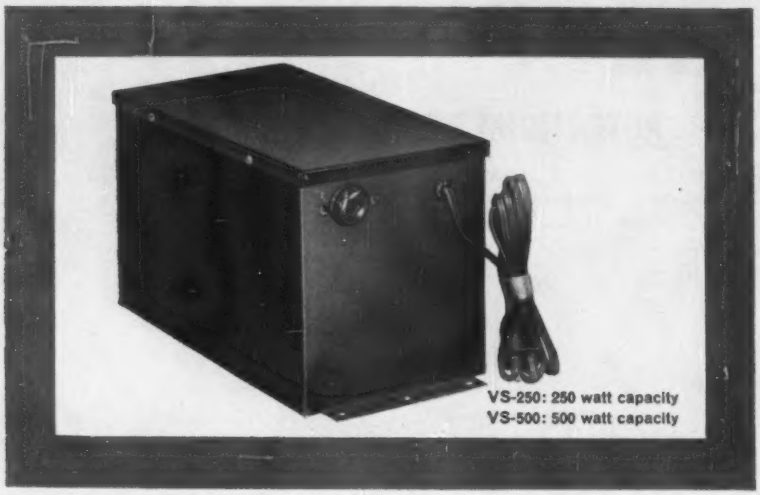
Potentiometers having sinusoid functions are available in 3", 2", 1⅞", 1½", 1¼", and ⅞" diameters. These potentiometers are available with two sliders giving independent outputs, one proportional to the sine and the other to the cosine of the shaft angle. Multiple units may be ganged and phased for cosine function or for other applications such as rotation of coordinates.

Precision in potentiometer-resistors feature wide temperature range, excellent environmental stability, highly precise mechanical construction and electrical performance.

Technical reports on the use of these units, and complete data are available on request.

TECHNOLOGY INSTRUMENT CORP
569 Main St., Acton, Mass. COlonial 3-7711
P.O. Box 3941, No. Hollywood, Calif. POplar 5-8620

NOW! stocked for immediate delivery



VS-250: 250 watt capacity
VS-500: 500 watt capacity

CHICAGO® VOLTAGE STABILIZING TRANSFORMERS

provide instantaneous, automatic stabilization to within ±½% for voltages from 95 to 130 V. A.C.

These CHICAGO units, of static-magnetic design, are now stocked for immediate delivery through electronic parts distributors. CHICAGO voltage stabilizing transformers offer you many important advantages:

* **EXTREMELY CONSTANT OUTPUT:** ±½% for input fluctuations from 95 to 130 volts A.C. with rated output of 117 volts, A.C., 60 cycle
* **RAPID STABILIZING ACTION**—usually a few cycles or less
* **UNAFFECTED BY POWER FACTOR**—or changes in load
* **ISOLATION TYPE**—provide complete isolation between input and output circuits
* **BUILT-IN CURRENT LIMITING CHARACTERISTICS**—protect load equipment from excessive fault currents
* **NO MOVING PARTS**—eliminates maintenance problems

CUSTOM DESIGN SERVICE: Units of other capacities, voltages and frequencies, or units to be built into your equipment, can be designed and produced in production quantities.

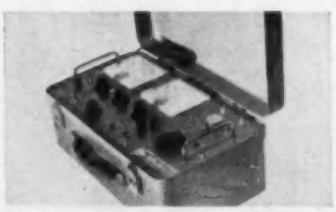
For complete details on these units write for Chicago Standard Bulletin CT-44 or see your Chicago Standard distributor.

CHICAGO STANDARD TRANSFORMER CORPORATION
3502 Addison Street • Chicago 18, Illinois
Export Sales: Roburn Agencies, Inc. • 431 Greenwich Street • New York 13, N. Y.

level meter and as a wide band amplifier. Specifications on full scale accuracy are: ±2 percent from 15 cps to 200 kc at 25 C and ±4 percent from 10 cps to 1 mc at −10 C to +55 C. Stability is ±1 percent over line voltage variations of 105 v to 125 v. **Circle 309 on Reader Service Card.**

Subminiature Pot high resolution

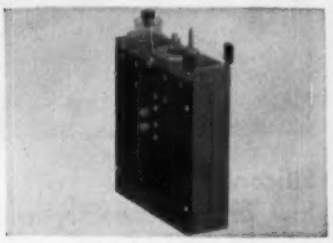
G. M. GIANNINI & Co., INC., 918 E. Green St., Pasadena 1, Calif. Model 875T precision pot provides high power dissipation at temperatures to 200 C. Weighing ⅛ oz, and with a diameter of only 0.875, it offers resolution as high as 0.06 percent with a standard linearity of 0.5 percent or better. Available resistances range from 200 ohms to 100,000 ohms per section, and up to 4 sections can be ganged on a common shaft. Torque is 0.1 oz-in. **Circle 310 on Reader Service Card.**



Test Set for microwave tubes

BRIGGS ASSOCIATES, INC., 10 DeKalb St., Norristown, Pa., has announced the model CD-3 current division tester for microwave tubes. Used in conjunction with an oscilloscope, the unit is capable of detecting actual and potential electrical or mechanical failure of 2C39 and similar tubes. The company

claims that use of the unit will result in major savings on tube procurement and even greater savings by the shortened down-time of inoperative stations. **Circle 311 on Reader Service Card.**



Galvanometer four writing media

PHOTRON INSTRUMENT CO., 6516 Detroit Ave., Cleveland 2, Ohio. Model G2 galvanometer employs four writing media, recording curvilinear and rectangular coordinates. Ink-writing pen, electric stylus and hot stylus elements are all easily interchangeable for quick conversion from one type of record to another. Response with ink-writing pen or electric stylus, with no compensation is flat to 40 cps, with hot stylus flat to 30 cps. Rise time is 0.015 sec. Linearity is 2 percent for the hot stylus and ±1.5 percent of full scale for ink-writing pen or electric stylus. **Circle 312 on Reader Service Card.**

Power Supply for klystron tubes

F-R MACHINE WORKS INC., 26-12 Borough Place, Woodside 77, N. Y. The Z819A klystron power supply is a compact versatile unit designed for low and medium power klystron tubes. Beam voltages up to 1,000 v at 85 mils, reflector voltages up to

Announcing

A new, highly accurate, yet inexpensive, method of speed measurement . . . monitoring . . . control. Applicable to machines, engines and transportation equipment.

TACH PAK

accepts a signal from a magnetic proximity pickup and conditions this signal for application to a meter calibrated directly in RPM . . . a control system . . . or a chart recorder. Installation is simple and there is NO maintenance problem.

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Control Specialists Since 1948

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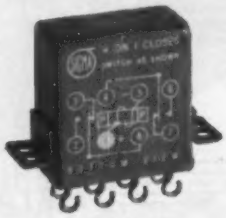
SEMINOLE DIVISION
THE AIRPAX PRODUCTS COMPANY — FORT LAUDERDALE, FLA.

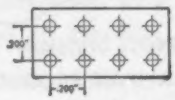
High level engineers conduct spirited discussion

The nearly fiendish delight of these specifying engineers comes from their discovery of a new relay which can meet the requirements of even the most horrible application.

It is the new Sigma Series 32, a DPDT magnetic latching relay which needs neither standby power nor a size reference. (Such spring-less, catch-less, trigger-less and *power*-less latching of the 32 solves all sorts of problems in wear, tear, heat and disturbances from power interruptions, all in one swoop.) Besides the distinguishing specs being discussed by the characters above, the 32 also has all the usual features you'd expect in this type of relay: e. g., hermetic seal; all standard mounting styles (eight grid-spaced pins, eight "J" hook solder terminals, plug-in types) for either flange or stud mounting; size 0.800″ x 0.400″ x 0.900″ high; weight 18 grams.

Whether your circuit is wet or dry, you might find a 32 is just what it needs. Preliminary descriptive sheets give a fairly complete rundown on the Series 32, or you could even buy a sample 32 to try.





SIGMA

SIGMA INSTRUMENTS, INC.,
62 Pearl Street, So. Braintree 85, Mass.

900 v and a −300 to +150 v grid supply are available. All voltages may be accurately pre-set. In addition, important voltages and currents are front-panel metered. **Circle 313 on Reader Service Card.**

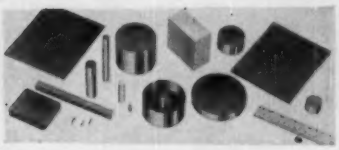
Silicon Rectifiers low priced

General Electric Co., Syracuse, N. Y., announces two new families of economy-priced low current silicon rectifiers. Four 100 C rectifiers have piv ratings of 100, 200, 300 and 400 v. They are all capable of 250 ma d-c rectified current output at 100 C ambient temperature. Six 125 C rectifiers have piv ratings of 100, 200, 300, 400, 500 and 600 v. **Circle 314 on Reader Service Card.**

Preamplifier d-c coupling type

Sanborn Co., 175 Wyman St., Waltham 54, Mass. Model 450-1300 d-c coupling preamplifier is designed for use with optical oscillographs, tape recorders, oscilloscopes and other indicating devices. It features high performance on single-ended or balanced signals. A three-stage circuit features cathode follower input and output, with overall gain provided by the second

stage push-pull transistor amplifier. Input is single-ended or push-pull, impedance 5 megohms each input side to ground; 50 mv input produces 1 v at output jack under maximum output load conditions. **Circle 315 on Reader Service Card.**



Diallyl Phthalate in machinable stock

MESA PLASTICS CO., 11751 Mississippi Ave., Los Angeles 25, Calif., has available blanks of diallyl phthalate plastic for machining prototypes. Blanks are furnished as machinable stock in a wide variety of shapes and sizes. Diallyl phthalate is the plastic which maintains insulation resistance, dielectric strength, and dimensions throughout exposure to high humidity and elevated temperature. Company states that the blanks are guaranteed free of voids, cracks, and porosities, thus insuring complete machinability to any configuration. **Circle 316 on Reader Service Card.**

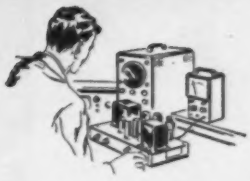
Transistors switching type

TEXAS INSTRUMENTS INC., P.O. Box 312, Dallas, Texas, announces two silicon switching transistors with switching times as low as 500 millimicroseconds in saturating circuitry. They are expected to have wide use in high speed computers and other switching applications requiring high reliability over wide temperature ranges. Packaged in the military and industry accepted round-welded JETEC TO-5 package, the 2N1005 and 2N1006 fea-

look what $24.50 buys in test equipment!

HEATHKITS GIVE YOU TWICE AS MUCH equipment for every dollar invested

The famous model V-7A Vacuum-Tube-Voltmeter is a perfect example of the high-quality instruments available from Heath at ½ the price you would expect to pay! Complete, only $24.50



Get the most out of your test equipment budget by utilizing HEATHKIT instruments in your laboratory or on your production line. Get high quality equipment, without paying the usual premium price, by dealing directly with the manufacturer, and by letting engineers or technicians assemble Heathkits between rush periods. Comprehensive instructions insure minimum construction time. You'll get more equipment for the same investment, and be able to fill your needs by choosing from the more than 100 different electronic kits by Heath. These are the most popular "do-it-yourself" kits in the world, so why not investigate their possibilities in your particular area of activity! Write for the free Heathkit catalog now!

Contains detailed descriptions of Heathkit models available, including VTVM's, scopes, generators, testers, bridges, power supplies, etc.

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SENSITIVE WIDE BAND ELECTRONIC VOLTMETER

measures 1 millivolt to 1000 volts from 15 cycles to 6 megacycles

Accuracy 3% to 3 mc; 5% above
Input impedance 7.5 mmfds shunted by 11 megs

When used without probe, sensitivity is increased to 100 MICROVOLTS but impedance is reduced to 25 mmfds and 1 megohm

MODEL 314
Price $285

- Same accuracy at *ALL* points on a logarithmic voltage scale and a uniform DB scale.
- Only *ONE* voltage scale to read with decade range switching.
- No "turnover" discrepancy on unsymmetrical waves.
- Easy-to-use probe with self-holding connector tip and unique supporting clamp.
- Low impedance ground return provided by supporting clamp.
- Stabilized by generous use of negative feedback.
- Can be used as 60 DB high fidelity video pre-amplifier.

All Ballantine instruments are **SENSITIVE - ACCURATE - DEPENDABLE**

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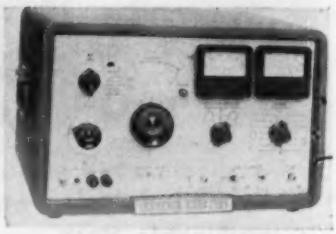
BALLANTINE LABORATORIES, INC.

100 FANNY ROAD, BOONTON, NEW JERSEY

ture d-c betas of 20-to-55 and 45-to-150, respectively. Both also have a collector dissipation of 125 mw at 25 C, 60 ohms saturation resistance, and 0.1 μa collector cutoff current. **Circle 317 on Reader Service Card.**



Signal Generator covers 50 kc-65 mc

Hewlett-Packard Co., 275 Page Mill Road, Palo Alto, Calif. The 606A signal generator covers the frequency range 50 kc to 65 mc. Output is 3 v full range, and may be continuously attenuated to 0.1 μv. Unit employs the master oscillator power amplifier circuit with a full feedback loop, insuring constant output over the full frequency range. It has extremely low distortion even at high modulation levels. **Circle 318 on Reader Service Card.**

Servo Multiplier two channels

Electro Precision Corp., Arkadelphia, Ark. Providing a static nulling area of 0.02 percent, the DLI-101 dual servo multiplier consists of two complete servo multiplier channels. Each channel provides for accurate, reliable multiplication of three variables by a fourth. Its age feature maintains constant loop gain for reference voltage variation in the range between 2 and 100 v. The 0.6 sec

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MEMO:

NEW PRODUCTS RELEASES

TO: ALL MANUFACTURERS

FROM: electronics

electronics publishes all new product items of interest to makers and users of electronic and allied equipment.

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full scale slow speed, the open loop gain in excess of 10,000, and the 0.1 percent linearity single turn pots combine to provide high dynamic and static accuracy. Composed of Digitrol plug-in building blocks, the DLI-101 offers maximum flexibility and ease of maintenance. **Circle 319 on Reader Service Card.**

Flat Cable
multiconductor

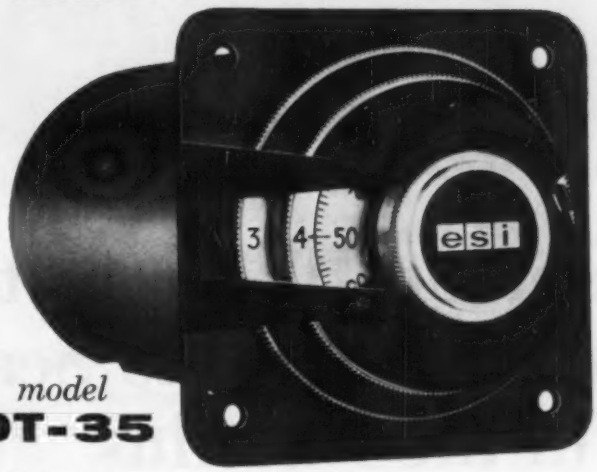
SPECTRA-STRIP WIRE AND CABLE CORP., 10052 Larson Ave., Garden Grove, Calif. Spectra-Strip is a multi-colored, multiconductor flat cable where interwire capacitance is stabilized. Using it, the design engineer has a choice of where he will place certain circuits in relation to others, and still stay within the same cable. By grounding the wire on each side of any particular lead, the need for a shielded wire or coaxial cable can be avoided in many cases. **Circle 320 on Reader Service Card.**

Load Isolator
low insertion loss

LITTON INDUSTRIES, 5873 Rodeo Rd., Los Angeles 16, Calif. Model R 307/S142 ferrite load isolator, particularly suited to electronic countermeasure application, gives a minimum of 10 db isolation over an 1,800 mc bandwidth. It is de-

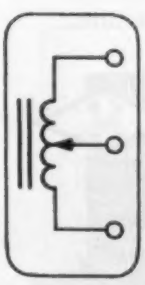
ANOTHER NEW DEKATRAN RATIO TRANSFORMER

Now in this actual small size



model
DT-35

A miniaturized concentric dial precision decade ratio transformer voltage divider for panel mounting. A two decade ratio transformer and an interpolating potentiometer provide 4 place readings of voltage ratio in one convenient straight line.



FEATURES

RUGGED CONSTRUCTION: Designed to meet wide range of environmental conditions.

SMALL SIZE: 6 units mount on 3x19-inch rack panel.

TRANSIENT SUPPRESSION: Switching transients have been minimized.

EASE OF READING: 4 place in-line window readout.

DIAL LOCK: Interpolating dial can be locked without affecting outer dials.

ACCURACY: ±0.01% at full scale; 50—10,000 cps.

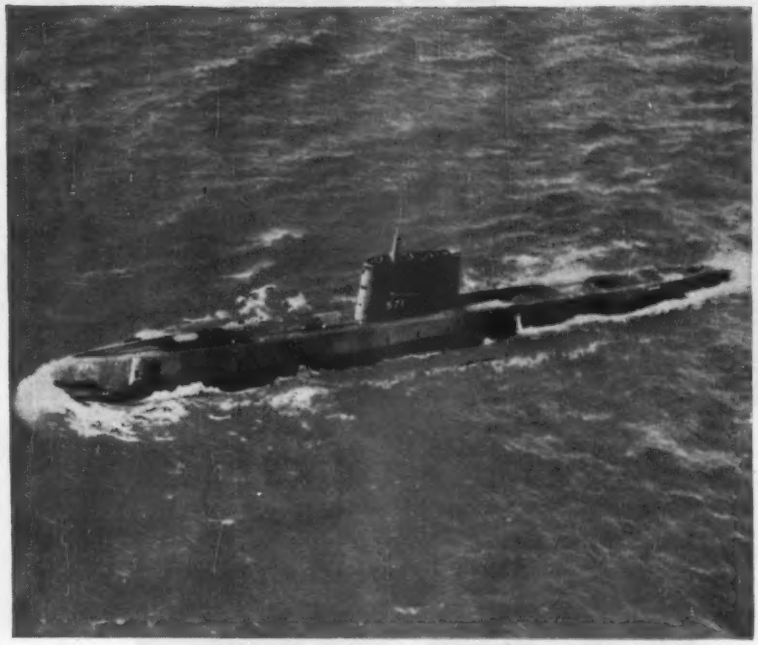
OUTPUT CURRENT: High current switches and low output impedance allow current rating of 1 ampere.

WEIGHT: 1¼ pounds net.
PRICE: $160.00.

Manufactured to meet applicable military specifications

esi

ELECTRO-MEASUREMENTS, INC.
7524 S. W. MACADAM AVENUE • PORTLAND 19, OREGON

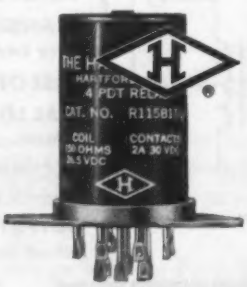


Official U. S. Navy Photograph

'Diamond H' Aircraft-type Relays Go to Sea in the Nautilus

Their reliability proven in such critical land and air applications as guided missiles, jet engine controls and fire control systems, "Diamond H" miniature, hermetically-sealed, aircraft-type relays were chosen by Westinghouse for an important role in the world's first atomic-powered submarine. They're used in the reactor control system of the Nautilus.

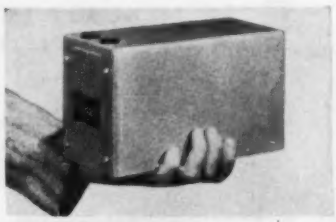
Possible performance characteristics of "Diamond H" Series R 4 PDT relays span such broad ranges that the modifications which can be arranged to meet particular sets of requirements are almost endless. They're fully described in Bulletin R250, a copy of which is yours for the asking. Our engineers will gladly work with you to develop a variation for your specific need.



THE HART MANUFACTURING COMPANY

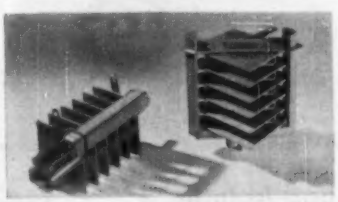
202 Bartholomew Avenue, Hartford 1, Conn.

signed for 1 db maximum insertion loss, but production isolators are showing only 0.5 to 0.8 db loss over most of the bandwidth. Operating power is 300 w c-w. Its length is 5.0 in. but this can be shortened to 3.5 in. without harming electrical characteristics. **Circle 321 on Reader Service Card.**



Voltage Regulators small and light

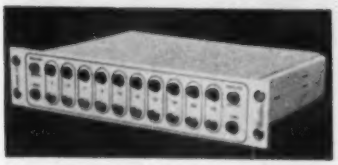
BRITISH INDUSTRIES CORP., 80 Shore Road, Port Washington, N. Y. The new Claude Lyons automatic line voltage regulators are completely independent of load from 0 to 100 percent of rated value, and are unaffected by input frequency variations over at least the range from 45 to 65 cps. Output waveform is a perfect reproduction of the input, with no harmonics added. Correction generally occurs within 3 cycles. Units are available for single phase or 3-phase inputs of 115 or 230 v nominally, with outputs from 575 va to 2,300 va. A typical regulator delivering 1,150 va, measures 5¾ in. high by 9 in. long by 4¾ in. wide, and weighs 11¼ lb. **Circle 322 on Reader Service Card.**



Selenium Rectifiers cover 150 to 450 ma

INTERNATIONAL TELEPHONE AND TELEGRAPH CORP., Clifton, N. J., announces the Federal Slim-Line of selenium rectifiers. The line presently consists of two sizes which

cover the range from 150 to 450 ma for half-wave rectifier applications and for B-plus supplies in voltage doubler circuits. Designed to meet the most rigid requirements of radio and tv receiver manufacturers, they feature a sturdy yoke-type construction which engages the corners of the selenium cells eliminating center holes and permitting the full area of the plate to be utilized. **Circle 323 on Reader Service Card.**



Converter digital-to-analog

NAVIGATION COMPUTER CORP., 1621 Snyder Ave., Philadelphia 45, Pa., has added a new, fully-transistorized digital-to-analog converter to its extensive line of pulse handling equipment. It is intended for the conversion of binary-coded data up to ten bits in length, into proportional d-c voltage of both polarities. Accepting inputs from a ten flip-flop storage register, the unit presents an output of ±15 ma into 10 ohms within 0.4 μsec after application of all input signals, and is linear within at least ±1 percent. **Circle 324 on Reader Service Card.**

Ceramic Capacitors layer-built

SPRAGUE ELECTRIC CO., North Adams, Mass., announces new layer-built Monolythic ceramic capacitors for transistorized circuitry. Into a small rectangular block ¼ in. by ¼ in. by ⅛ in. thick, it is possible to pack a capacitance of as much as 0.75 μf at 24 v d-c. The new capaci-

ERIE WIRE LEAD PAC FEATURES

- **Applicable for universal wiring**
- **Dual protection — leads mechanically wrapped and soldered**
- **High solderability wire leads to base terminals**

Erie "PAC" is now available with wire leads in addition to printed board terminals. Manufacturers using point-to-point wiring can now gain the many advantages of the "PAC" Modular System.

The wire leads are mechanically crimped, then soldered to the respective component terminations.

SPECIFICATIONS

Wire Leads	Standard, 22 AWG Special, 20 AWG
Capacitance Range—ceramic dielectric	10 mmf — .01 mfd
—mylar dielectric	.01 mfd — .1 mfd
Capacitance Tolerance*	+100% −0%, ±20%, ±10%, ±5%
Capacitance VDCW*—ceramic dielectric	500 VDC, 1 KVDC
—mylar dielectric	100 VDC, 200 VDC, 400 VDC
Resistance Range	10Ω — 50 megΩ
Resistance Tolerance	±5%, ±10%, ±20%
Resistor Rating	½ watt @ 350 VDCW

*Dependent upon capacity

Write for samples of ERIE Wire Lead PAC to fit your requirements and for detailed specifications contained in ERIE Engineering Bulletin 450-2.

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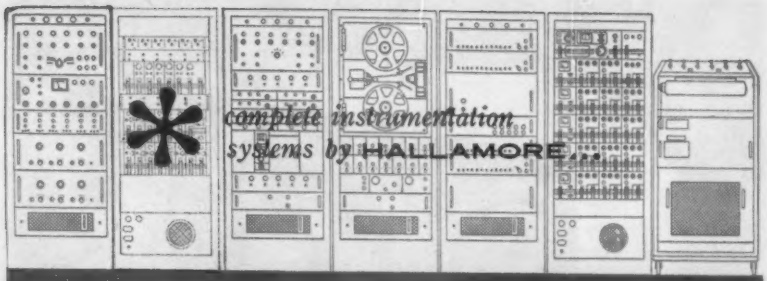
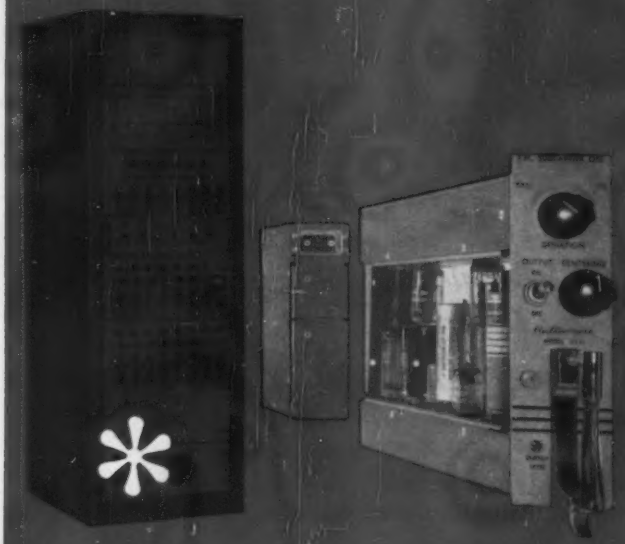


A NEW CONCEPT IN VOLTAGE CONTROLLED OSCILLATORS



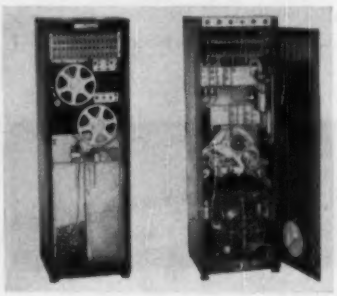
module size 2" x 7½"... adjustable internal bias. all standard IRIG channels... The voltage controlled subcarrier oscillator, shown in this building block type FM instrumentation system, is the latest in a series of building-block components developed by Hallamore Electronics Company for the instrumentation field. Engineered for stability and flexibility, the unit designated HEC-0161 is entirely compatible with existing systems and offers unusual advantages in improved accuracy, operational simplicity, and the saving of space. A standard module case will accommodate up to six oscillators and a summing amplifier, HEC-0166. A common supply, HEC-0144, integral to the module case, provides the power in this configuration, while an individual supply, HEC-0143, is available to provide complete isolation for each transducer input.

The basic Hallamore voltage controlled subcarrier oscillator unit, HEC-0161, can be instantly converted to any IRIG telemetering channel by plug-in channel selectors, HEC-0164, and output filters, HEC-0165. Plug-in units for non-standard channels and bandwidths can be supplied. For complete specifications and operational data, write Hallamore Electronics Company, Dept. 88, 8352 Brookhurst Avenue, Anaheim, Calif.

HALLAMORE ELECTRONICS COMPANY *a division of the SIEGLER CORPORATION*

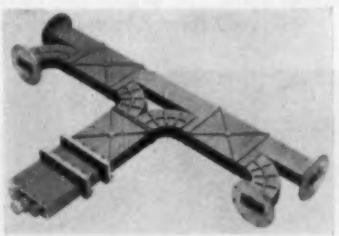
Engineers . . . for ideal working conditions with a dynamic, creative organization, address resume to Chief Engineer.

tors are built by spraying alternate layers of ceramic dielectric material and silver electrodes until the desired capacitance is achieved, using automatic machinery especially made for the purpose. Resultant capacitors are solid homogeneous blocks. **Circle 325 on Reader Service Card.**



Data Recorder all-transistorized

D. G. C. Hare Co., 30 Burtis Ave., New Canaan, Conn., announces model 424 fully-transistorized tape transport system; a new type of data recording system to record, store and reproduce analog or digital data. Two independent capstan drives, with high speed start-stop times of less than 2 millisec, permit tape to operate in either direction at speeds from 7½ to 60 ips. A high speed of 150 ips is also available for special applications. **Circle 326 on Reader Service Card.**



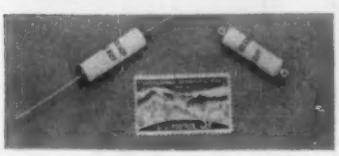
Diplexer for S-band

Bomac Laboratories, Inc., Salem Road, Beverly, Mass. The BL-584 S-band diplexer is used primarily for connecting two transmitters operating at different frequencies to a common antenna feed, with very low crosstalk between them. It also separates the

two echo signals at the two frequencies into the approximate receiver channels. A pair of ganged plungers provides continuous variation of the two diplexing frequencies. A replaceable section makes it possible to diplex many combinations of frequencies. The unit can also be used as a continuously variable directional coupler. **Circle 327 on Reader Service Card.**

D-C Power Supply for lab and line

WESTINGHOUSE ELECTRIC CORP., 356 Collins Ave., Pittsburgh 6, Pa. Model 646 Volt-Pak is a general-purpose d-c power supply for industrial laboratory and production line use. Rated output is 0-450 v d-c, 250-ma continuous, or 500-ma intermittent load. A-c output is rated 6.3 v, 3.0 amperes. Selenium rectifiers are used to provide instant operation and reduce maintenance problems. Smooth voltage control from zero to full output is obtained from a variable autotransformer. **Circle 328 on Reader Service Card.**



Reference Element reduced size

U.S. SEMICONDUCTOR PRODUCTS, INC., Phoenix, Arizona. A new diffused silicon voltage reference ele-

REVERE Thermocouple Wires

bought FIRST because they LAST

Day in, day out . . . in aircraft, refinery vessels, fire protection systems, furnaces, molding presses . . . under extremes of heat and cold, moisture, chemicals and abrasion, Revere thermocouple wires stand up because they're tailor-made for each application.

Solid or stranded chromel-alumel, iron-constantan and copper-constantan conductors available in various gauge sizes. Wrapped, carded or extruded insulations include polyethylene, vinyl, nylon, Revcothene*, Teflon†, fiber glass, asbestos and pure silica glass fiber. Outer braids treated with flame and abrasion resistant saturants. Metallic braids for severe service. L & N, SAMA or NBS calibration. Wires constructed to Military Specifications MIL-W-5845, MIL-W-5846 and MIL-W-5908.

Whether your application requires extreme flexibility, chemical inertness or resistance to temperature, flame, abrasion, moisture, acids or solvents, a standard or special Revere thermocouple wire will meet your specific need.

*Revere trade name †E. I. DuPont trademark

Send for Engineering Bulletin No. 1701 describing Revere Thermocouple Wires and Extension Leads.

21

REVERE CORPORATION OF AMERICA

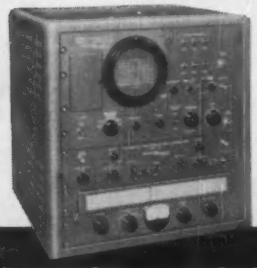
Wallingford, Connecticut

A SUBSIDIARY OF NEPTUNE METER COMPANY

neptune

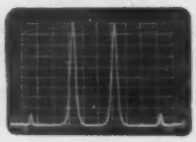
for SSB transmissions:
a new rapid test instrument

- incredibly simple to operate
- compact — complete unit occupies only 19 ¼" of panel height
- exceptionally low-priced



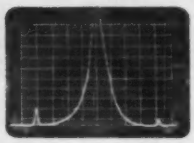
PANORAMIC'S
SSB-3

Now, Panoramic has incorporated in one convenient package the equipment you need to set up . . . adjust . . . monitor . . . trouble-shoot SSB and AM transmissions.



TWO TONE TEST*
Fixed sweep width 2000 cps. Full scale log sideband tones 1.5 kc and 2.1 kc from carrier (not shown). Odd order I.M. distortion products down 37 db.

HUM TEST*
Indication of one sideband in above photo increased 20 db. Sweep width set to 150 cps reveals hum sidebands down 54 db and 60 db.



a sensitive spectrum analyzer
Panoramic's Model SB-12a Panalyzor

- pre-set sweep widths of 150, 500, 2000, 10,000 and 30,000 cps with automatic optimum resolution for fast, easy operation
- continuously variable sweep width up to 100 kc for additional flexibility
- 60 db dynamic range
- 60 cps hum sidebands measurable to —60 db
- high order sweep stability thru AFC net work
- precisely calibrated lin and log amplitude scales
- standard 5" CRT with camera mount bezel
- two auxiliary outputs for chart recorder or large screen CRT

a stable tuning head
- 2 mc to 39 mc range with direct reading dial free of hum modulation

a two-tone generator
- two separate audio oscillators with independent frequency and amplitude controls
- output 2 volts max. per tone into 600 ohm load, combined in linear mixer
- I.M. of two tones less than —60 db

internal calibrating circuitry
- two RF signal sources simulate two-tone test and check internal distortion and hum of analyzer
- center frequency marker with external AM provisions for sweep width calibrations

* *See Panoramic Analyzer No. 3 describing testing techniques, etc., for single sidebands. A copy is yours for the asking.*

dependable **CERTIFIED SPECIFICATIONS** *for accurate data*

PANORAMIC
RADIO PRODUCTS, INC.

Write, wire, phone RIGHT NOW for technical bulletin and prices on the new SSB-3. Panoramic instruments are PROVED PERFORMERS in laboratories, plants and military installations all over the world. Send for our new CATALOG DIGEST and ask to be put on our regular mailing list for The PANORAMIC ANALYZER featuring application data.

530 So. Fulton Ave., Mount Vernon, N. Y. • Phone: OWens 9-4600
Cables: Panoramic, Mount Vernon, N. Y. State

ment measures only 1 in. long by ⅜ in. o-d with axial leads. Reduced package size results from a unique silicon wafer sandwiching technique. Units are now available with 0.0005 percent per deg C temperature coefficient, with an operating temperature range from −65 C to +200 C. They may be had in both axial lead and lug terminal styles, to fill any requirements for a reference voltage, such as used in computers, measuring instruments and controls. **Circle 329 on Reader Service Card.**

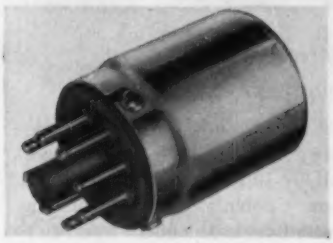
Rectifier Control magnetic type

FAIRFIELD ENGINEERING CORP., 934 Hope St., Springdale, Conn. Driving GE's silicon controlled rectifiers, type ZJ-39A, in power control systems and servo drives is greatly simplified by the use of a new magnetic rectifier control (MRC). The unit operates from low-level a-c or d-c control signals to develop a steep wavefront (current) to trigger the GE rectifiers. **Circle 330 on Reader Service Card.**

Filters for narrow bandwidth

WHITE INSTRUMENT LABORATORIES, Box 9006, Allandale Station, Austin 17, Texas. Type FP2 filters

are two-resonator networks designed as vacuum tube coupling circuits where relatively narrow bandwidth is desirable. FP2A filters operate from a typical triode amplifier or any other source of approximately 10 K ohms into a grid. FP2B filters operate from a typical cathode follower or other 500 to 600 ohm source into a grid. The −3 db pass band is ±5 percent, skirt attenuation is 40 db one octave from the center frequency, phase shift is approximately zero at the center frequency, and voltage ratio is 2. **Circle 331 on Reader Service Card.**

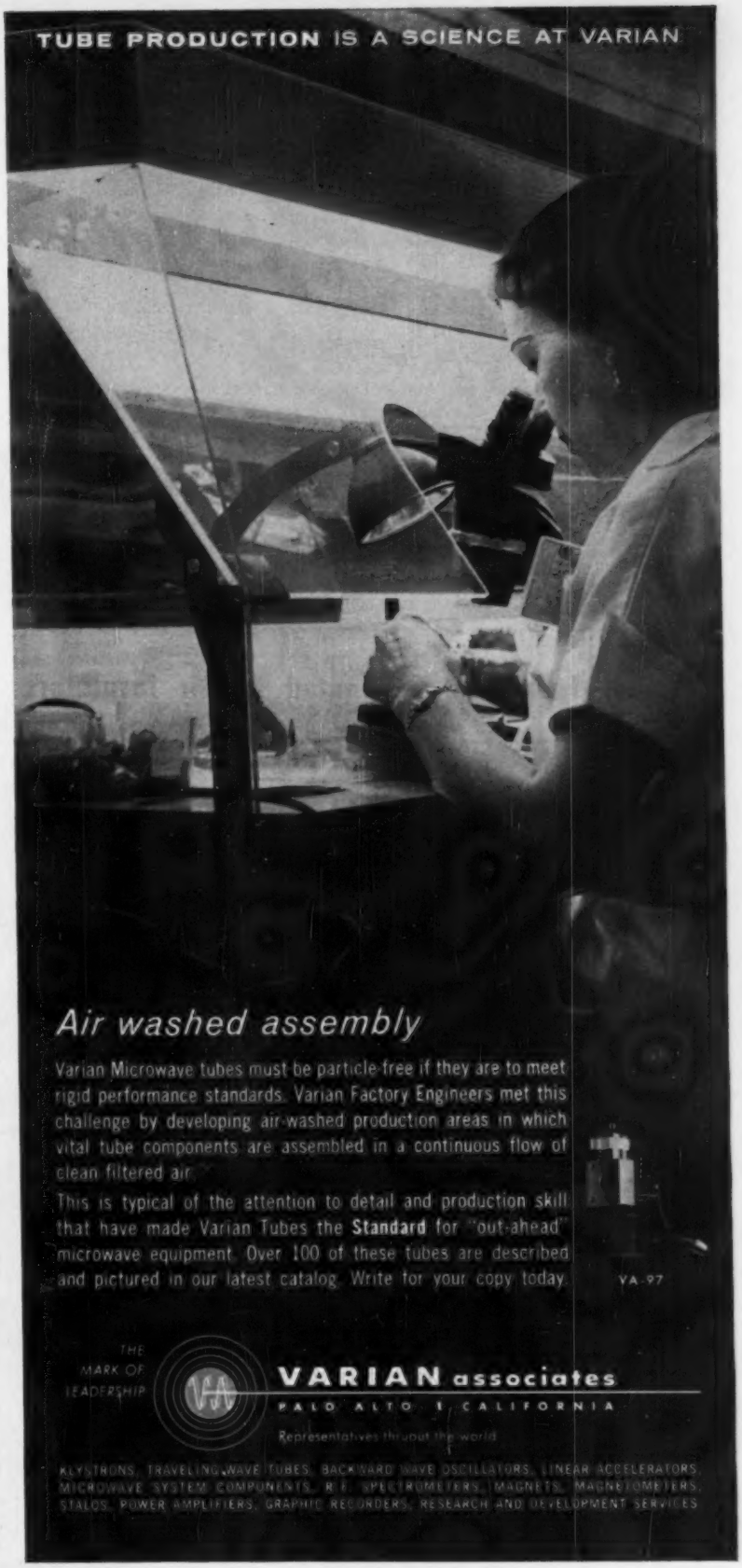


Crystal Oven high stability

Bliley Electric Co., Union Station Bldg., Erie, Pa., announces a new high stability crystal and components oven series. The TCO-14 series will accommodate two Bliley BH6A crystals or transistors, coils and other circuit elements requiring temperature stabilization. Stability is ± 2 C. Operating voltages are 6.3 v, 12.6 v or 26.5 v. **Circle 332 on Reader Service Card.**

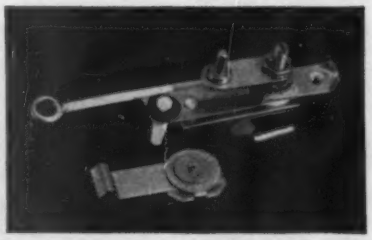
Pulse Counter variable scale

Burroughs Corp., Plainfield, N. J., announces type 1791 variable scale megacycle counter. It features the shielded type BD300 beam switching tube—a decimal counting device, which enables the


TUBE PRODUCTION IS A SCIENCE AT VARIAN
Air washed assembly
Varian Microwave tubes must be particle-free if they are to meet rigid performance standards. Varian Factory Engineers met this challenge by developing air-washed production areas in which vital tube components are assembled in a continuous flow of clean filtered air.
This is typical of the attention to detail and production skill that have made Varian Tubes the Standard for "out-ahead" microwave equipment. Over 100 of these tubes are described and pictured in our latest catalog. Write for your copy today.
VA-97
THE MARK OF LEADERSHIP
VARIAN associates
PALO ALTO 5 CALIFORNIA
Representatives thruout the world
KLYSTRONS, TRAVELING-WAVE TUBES, BACKWARD WAVE OSCILLATORS, LINEAR ACCELERATORS, MICROWAVE SYSTEM COMPONENTS, R.F. SPECTROMETERS, MAGNETS, MAGNETOMETERS, STALOS, POWER AMPLIFIERS, GRAPHIC RECORDERS, RESEARCH AND DEVELOPMENT SERVICES

6 Taylor-Fabricated Laminated Plastic Insulators Protect Control Elements of GE Automatic Toaster

These insulators for the pop-up mechanism, color control unit, and heating element in the General Electric Automatic Toaster are made of continuous filament woven glass fabric with melamine resin bond. This Taylor Fibre Co. material was selected for its ability to withstand the temperatures encountered in the toasting operation, its excellent arc resistance and mechanical strength, and its cost, which is lower than that of the mica insulators formerly used.



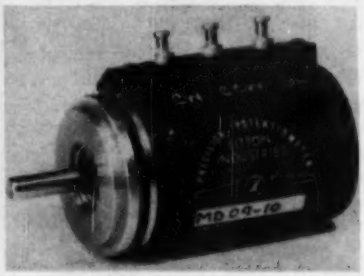
Another factor in the decision was the capacity of Taylor Fibre Co. to produce the fabricated parts to specification, and in the large quantities required, at reasonable cost.

You, too, may have applications which can utilize the combination of physical, mechanical and electrical properties found only in laminated plastics. Our application engineers will be glad to discuss them with you, offer engineering assistance, and recommend a Taylor grade that will fit your specific requirements. Our plants at Norristown, Pa., and La Verne, Calif., are both fully equipped for fast supply of basic materials and finished parts. Write us for detailed information or to arrange for a Taylor Fibre man to call on you. TAYLOR FIBRE CO., Norristown 40, Pa.

Taylor

LAMINATED PLASTICS VULCANIZED FIBRE

unit to count and reset to frequencies of 1 mc. Additional features include reset time of less than 1 μsec, directly cascadable units, and the availability of two types of outputs. **Circle 333 on Reader Service Card.**



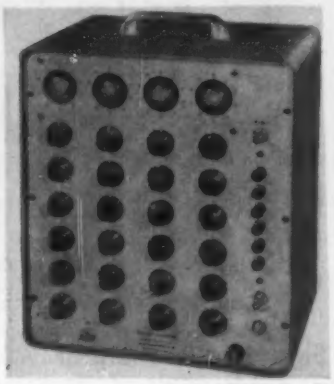
Miniature Pot multiturn

LITTON INDUSTRIES, 5873 Rodeo Road, Los Angeles 16, Calif. Model MD09-10 is a ⅜ in. diameter multiturn potentiometer. Company guarantees independent linearity to ±0.015 percent and resolution to 0.0085 percent. Unit is manufactured with a ceramic core, a drawn metal case with O-ring seal, welded tap leads, stainless steel ball bearings protected with a Teflon seal and a balanced cylindrical rotor and slider assembly. **Circle 334 on Reader Service Card.**

Epoxy Adhesive for preforms

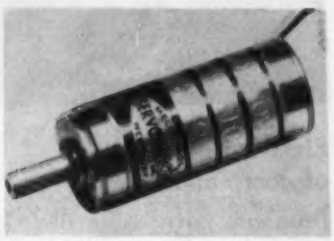
EMERSON & CUMING, INC., 869 Washington St., Canton, Mass. Eccobond SBC is a single part epoxy adhesive which can be molded readily into a preform. The material is supplied in powder form, heated slightly, molded under moderate pressure, and then allowed to cool. The resultant preforms are

then usable as a quick setting adhesive for numerous jobs such as bonding anode caps to vacuum tubes, cementing tube bases, or any job where an easy to handle, rigid preform simplifies the operation. Complete cure of the preform is completed in a few minutes at temperatures from 350 to 500 F. **Circle 335 on Reader Service Card.**



Preset Counters
multiple type

FREED TRANSFORMER CO., INC., 1788 Weirfield St., Brooklyn 27, N. Y. The 2020 preset counters can be supplied with multiple groups of presetting controls for use in all vital industrial operations for accurate, high speed sequential predetermining counting and control. With the new counters a complete program can be preset for winding multiple tapped coils or for any event which requires a machine controlled at different predetermined counts. **Circle 336 on Reader Service Card.**



Synchronous Motor
weighs only 0.9 oz

MECHATROL, a division of Servomechanisms, Inc., 1200 Prospect Ave., Westbury, L. I., N. Y. A

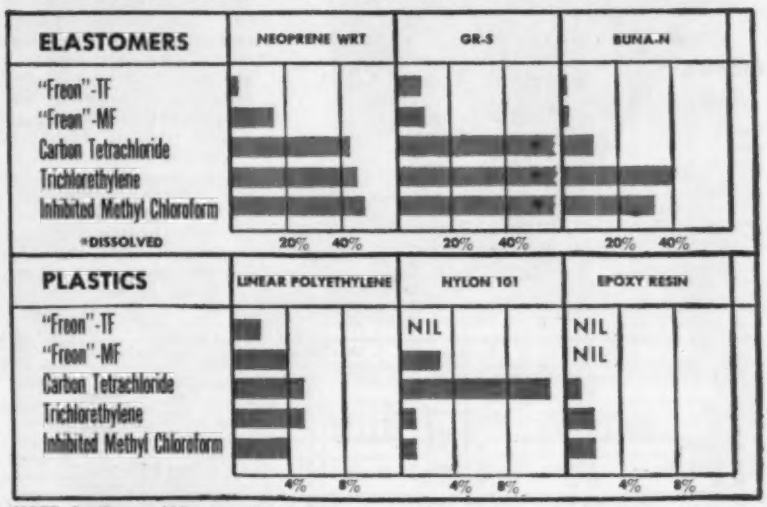
DU PONT REPORTS ON **FREON®** **SOLVENTS**
for precision-parts cleaning

New solvents by Du Pont clean with minimum effects to elastomer and plastic parts

Now you can protect delicate, costly parts during cleaning operations by using "Freon" solvents. For safe cleaning of precision parts and instruments, Du Pont's new "Freon" solvents remove oil and grease, yet show minimum effects on elastomeric and plastic materials.

Chart below compares linear swell of some commonly used plastics and elastomers due to "Freon" with that caused by other solvents. "Freon" cleans effectively, yet is noncorrosive without inhibitors, nonflammable, and much less toxic than ordinary solvents.

PERCENT LINEAR SWELL IN VARIOUS SOLVENTS (100 HRS. @ 130°F.)



NOTE: Swelling would be approximately nil in all cases with "Freon" solvents at their boiling points. Swelling would be considerably greater with all other solvents at their boiling points.

Freon† solvents minimize cleaning hazards. These new solvents by Du Pont offer outstanding safety for men and equipment. "Freon" is much less toxic than ordinary solvents—will not burn or explode. "Freon" is noncorrosive without inhibitors—is exceptionally stable even in the presence of oils and water. "Freon" solvents are suitable for a wide range of uses where ordinary solvents create problems of corrosion or damage to plastics, paint and elastomers.

For your free copy of Du Pont's booklet describing the unique properties of "Freon" solvents, mail the coupon or write: E. I. du Pont de Nemours & Co. (Inc.), "Freon" Products Division **5210**, Wilmington 98, Del.

DU PONT
REG. U.S. PAT. OFF.
BETTER THINGS FOR BETTER LIVING...THROUGH CHEMISTRY

†Freon is Du Pont's registered trademark for its fluorinated hydrocarbon solvents.

FREE BOOKLET
Mail coupon for your free copy of booklet describing properties of "Freon" solvents . . . there's no obligation.

E. I. du Pont de Nemours & Co. (Inc.)
"Freon" Products Division **5210**, Wilmington 98, Del.
Please send me your free booklet describing the unique properties of "Freon" solvents for precision-parts cleaning.

*Name*_____ *Position*_____
*Company*_____
*Address*_____
*City*_____ *Zone*____ *State*_____

BIRD

"Termaline" 50 ohm Coaxial Line LOAD RESISTORS

MODEL 888

1200 Watts Continuous Duty

1500 Watts Intermittent Duty

2 to 3 KW Continuous Duty with forced air cooling

Input connections are available to terminate most coaxial lines.

BIRD "Termaline" Load Resistors are designed to provide a constant impedance of 50 ohm from DC through the useful coaxial frequency range. Each Resistor is intended to simulate an infinite length of 50-ohm line, thus providing an almost reflectionless termination. Low VSWR and freedom from radiation makes the Bird Loads extremely useful during adjustment and testing. Measurements of power are also possible when these Resistors are used as terminations for the appropriate Bird "Thruline" Directional Wattmeters. Accuracy in RF resistance, rugged ability to absorb power and absence of any need for adjustments has long characterized the Bird "Termaline" Load Resistors. For specifications on standard models see chart below. For other requirements please phone or write. Our long experience in this field may assist you in the solution of your problem.

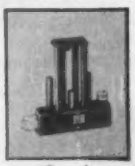
Model	Max. Power	Freq. Range	Max. VSWR*	Input Connector
80-M	5 W	0-4 KMC	1.2	Type "N" male
80-F	5 W	0-4 KMC	1.2	Type "N" female
80-CM	5 W	0-4 KMC	1.2	Type "C" male
80-CF	5 W	0-4 KMC	1.2	Type "C" female
80-BNCM	5 W	0-4 KMC	1.2	Type BNC male
80-BNCF	5 W	0-4 KMC	1.2	Type BNC female
80-A	20 W	0-1000 MC	1.1	Type "N" female
81	50 W	0-4 KMC	1.2	Type "N" female
81-B	80 W	0-4 KMC	1.2	Type "N" female
82-A	500 W	0-3.3 KMC	1.2	Coplanar. Adapter to UG-21B/U supplied
82-AU	500 W	0-3.3 KMC	1.2	"LC" Jack mates with UG-154/U plug on RG-17/U cable
82-C	2500 W**	0-3.3 KMC	1.2	Coplanar. Fittings and cable assemblies for flexible and rigid coax lines available

*VSWR on all models is 1.1 max. from DC to 1000 MC.
**Water cooled

Other Bird Instruments

"Thruline" Directional RF Wattmeters

"Termaline" RF Absorption Wattmeters

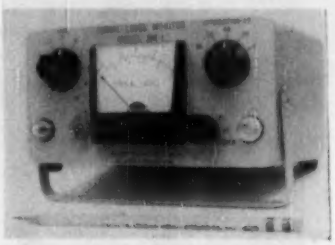


Coaxial RF Filters

Coaxial RF Switches

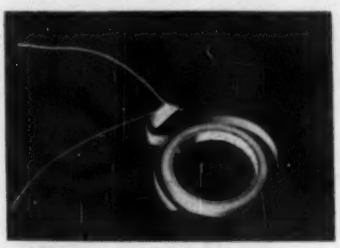
BIRD ELECTRONIC CORP.
EXpress 1-3535
1800 E. 38 St., Cleveland 14, Ohio
Western Representative:
VAN GROOS COMPANY, Woodland Hills, Calif.

synchronous motor in BuOrd size 5, weighs only 0.9 oz. The standard motor, 5H1-1, operates from a single phase power supply at 26 v. However, units can be supplied to operate from 2 or 3 phase supplies at speeds of 12,000 or 8,000 rpm. Power output is 5 w total; pull-out torque, 0.07 oz-in.; pull-in torque, 0.04 oz-in.; starting time, 30 millisec; operating temperature range, −55 C to +85 C. **Circle 337 on Reader Service Card.**



Signal Level Monitor portable unit

SCIENTIFIC-ATLANTA, INC., 2162 Piedmont Road, N.E., Atlanta 9, Ga. Model SM-1 signal level monitor is a portable, light weight instrument designed primarily as a versatile and time saving accessory for antenna and r-f laboratories. It features high sensitivity, operation with either c-w or modulated r-f signals, tuned or untuned selective amplifier, no d-c drift, precision attenuators and small size. **Circle 338 on Reader Service Card.**



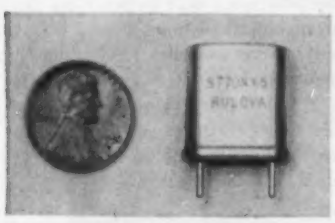
Electrical Tape of cast Teflon

DILECTRIX CORP., Allen Blvd. & Grand Ave., Farmingdale, L. I., N. Y. A new cast Teflon film for various electrical-tape applications possesses such advantages as unusually strong dielectric characteristics, performance over a wide thermal range, negligible water absorp-

tion, low rate of moisture vapor permeability, and inertness to chemicals and solvents. Cast Teflon films are available in continuous roll lengths of 100 and 500 ft and in widths from ¼ in. to 12 in. in increments of ⅛ in. **Circle 339 on Reader Service Card.**

Power Supplies transistorized

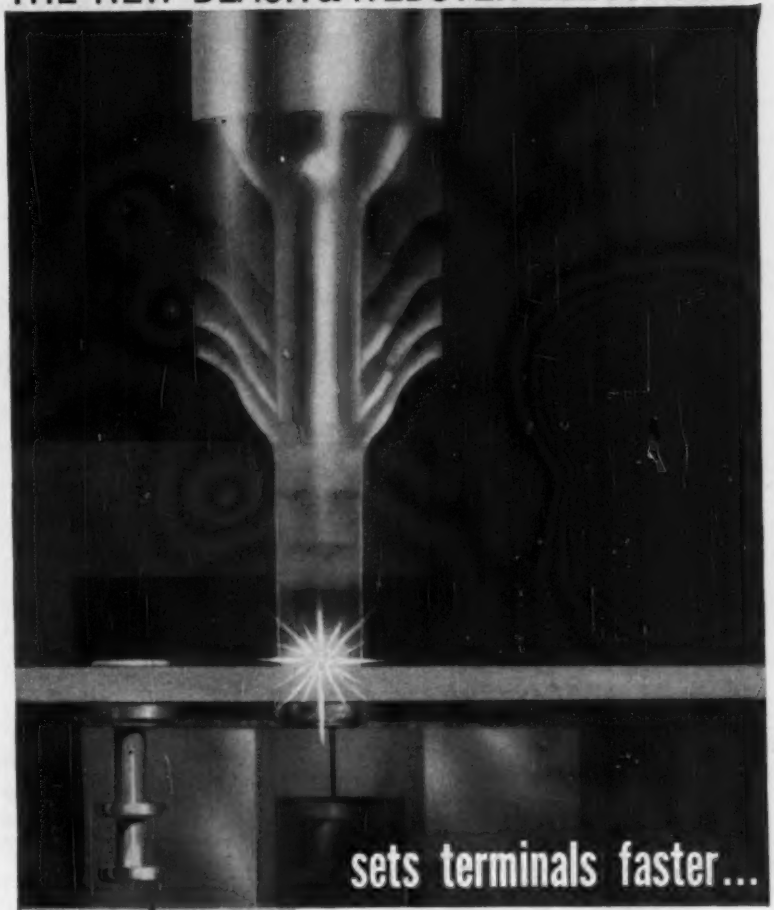
UNIVERSAL TRANSISTOR PRODUCTS CORP., 17 Brooklyn Ave., Westbury, L. I., N. Y., announces a series of fully transistorized power supplies that provide the output required to operate receiver installations. The rectified, filtered units wire directly to battery and mobile equipment. Features include operating life in excess of 10,000 hr; efficiency to 85 percent; elimination of high current starting surges, moving parts, and vibrator hash; and extremely low ripple. **Circle 340 on Reader Service Card.**



Crystals small and stable

BULOVA WATCH CO., Woodside 77, N. Y. The ST-7ONXS miniature crystal series are hermetically sealed and mounted in the HC-6/U military type holder. They cover a frequency range of 100 kc to 250 kc, with a frequency tolerance of ±0.015 percent over a −55 C to +90 C temperature range. Overall size is ¾ in. wide by ⅜ in. deep by 1⅛ in. high, with weight about 1

THE NEW BLACK & WEBSTER ELECTROSET



with fewer rejects...

than any production tool you have ever used

The new Black & Webster ELECTROSET is an all electric solenoid-operated high production tool for setting standard turret type or seamed terminals. It speeds up production, reduces costs because it is automatic, accurate — and lightning fast. Here's how:

OPERATION—Terminals are fed to staking nest automatically from 8" vibrator feeder. Operator simply places board over terminal and triggers Electropunch, staking terminal in the board. As operator withdraws board, feed automatically advances new terminal to nest.

FASTER PRODUCTION—limited only by operator speed in feeding board. ELECTROSET has achieved rates to 3600 per hour.

CONTROLLED IMPACT—careful control through variable voltage transformer, capable of varying impact from feather touch to 3500 lbs. Accurate, positive "punch" eliminates rejects from too-light or too-heavy blows.

EASY POSITIONING—light beam under punch head indicates exact terminal location, when terminal is hidden by board.

VERSATILE—adaptable to feeding and setting contacts, pins, shoulder studs and plug nuts.

SEND SAMPLE TERMINAL FOR EVALUATION.

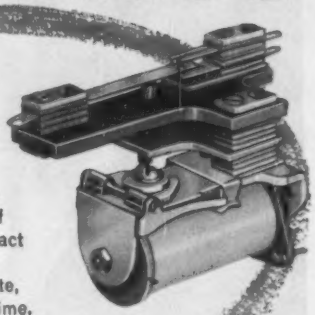
BLACK & WEBSTER, INC.

DEPT. E, 445 WATERTOWN STREET, NEWTON 58, MASSACHUSETTS

SEND FOR DATA ON THESE NEW RELAYS

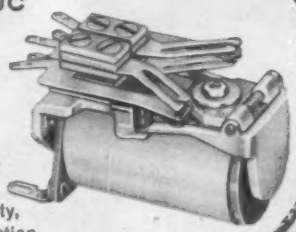
TYPE TJV
VIDEO SWITCHING RELAY

Specially engineered for carrying video and other high frequency currents. Unusual flexibility of design permits a wide range of contact spring assemblies and combinations to be used. Fast operate, release and transfer time.

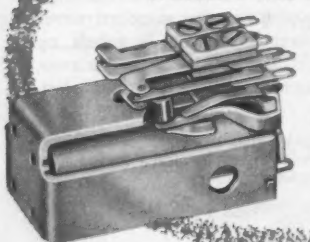


TYPE TJC
VERSATILE COMPACT RELAY

Incorporates the best characteristics of the standard telephone type and the small lightweight relay. Features include rugged construction, sensitivity, large contact spring capacity, compact size. Independent-action twin contacts.



TYPE TQ
SENSITIVE MINIATURE RELAY



Operates on DC coil signals at sensitivities from 20 to 100 milliwatts. Contact rating with resistive load at 28 VDC. or 115 VAC; silver contacts, 3 amperes. Shock, up to 50 G. Vibration up to 10 G, from 10 to 500 cps.

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3349 ADDISON ST., CHICAGO 18, ILL.

RELAYS • SOLENOIDS • COILS • SWITCHES • HERMETIC SEALING

oz. Crystals meet all environmental conditions of MIL-E-5272, MIL-E-5400 and MIL Std. 202. **Circle 341 on Reader Service Card.**

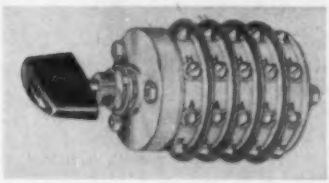
Terminal Setter automatic machine

Black & Webster, Inc., 445 Watertown St., Newton 58, Mass., has developed an automatic machine for setting standard turret-type and "bead chain" terminals in terminal boards. The new automatic Electroset, model FST, is built around an Electropunch and a vibratory feeder. A feeding mechanism is capable of presenting terminals in a staking nest at the rate of 100 per min. Ultimate production rates will depend on the arrangement of holes in the board, and operator skill. The vibratory feeder will hold approximately 2,000 terminals. On the standard Electroset, boards up to 10 in. in width can be handled. **Circle 342 on Reader Service Card.**

Deviation Meter readings in kc

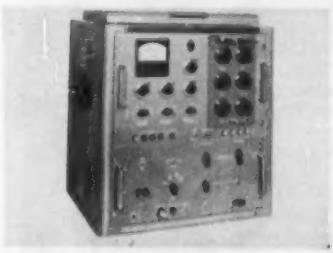
Nems-Clarke Co., 919 Jesup-Blair Drive, Silver Spring, Md., announces a deviation meter for use with many models of their receivers

in telemetry applications. The DM-100, its associated circuitry and power supply are mounted on a 3½ in. by 19 in. panel for rack mounting. In operation it is bridged across the video output of the receiver. Unit permits a direct reading of the deviation in kc of the subcarrier oscillators used in a telemetry system. A three-position switch permits full scale readings of 25, 50 and 75 kc. **Circle 343 on Reader Service Card.**



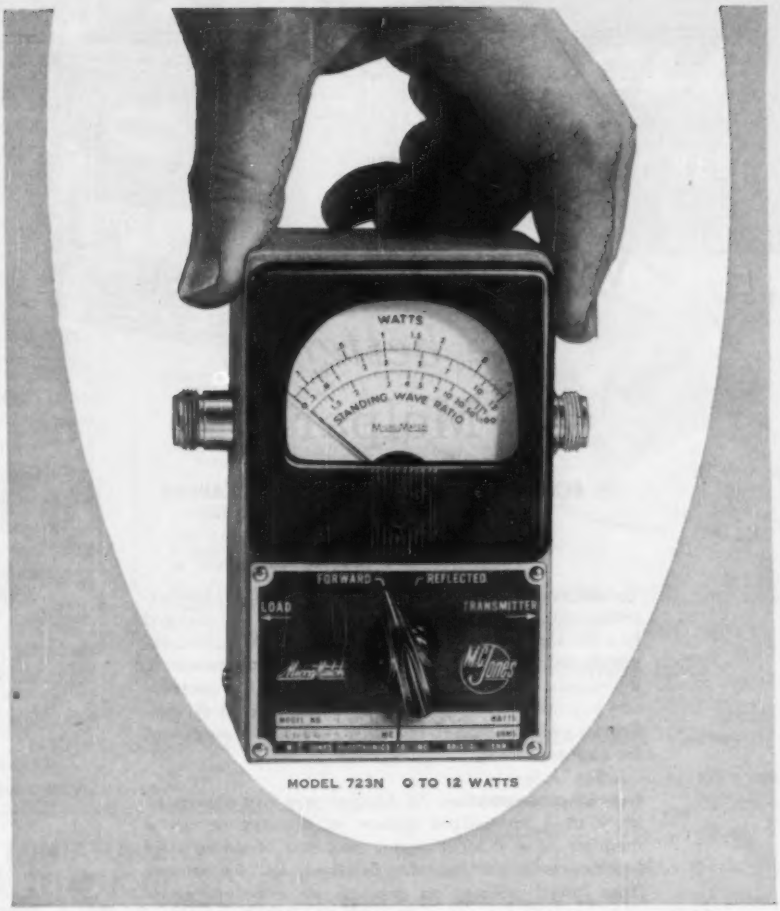
Rotary Switch multipole

ELECTRO SWITCH CORP., Weymouth 88, Mass. The new, compact type JL rotary multipole switch has a maximum of eight contact positions and up to ten sections, controlled by a single knob. It is furnished to meet BuShips Drawing 9000-S6 202-74422, with 3, 5 or 10 sections; the modified type JL can be furnished with any number of sections, up to ten. Electrical rating is 5 amperes 125 v a-c. **Circle 344 on Reader Service Card.**



Diode Test Set automatic unit

MEASUREMENTS RESEARCH CO., 3801 Castor Ave., Philadelphia 24, Pa., has introduced a new automatic diode test set. Model 5002AB automatically compares the d-c forward and reverse characteristics of semiconductor diodes against preset limits and presents



VSWR and RF WATTMETERS

25 MCS TO 3000 MCS

These rugged, compact units accurately measure and indicate the RF power and VSWR of coaxial transmission lines. Each type combines a frequency insensitive bidirectional coupler and complete indicator circuit in one small case. Accuracy of power measurement is ± 5% of full scale.

Model No.	Frequency Range (Mcs)	Power Range (Watts)	RF Connectors
712N	25—1000	0-2.5; 5; 10 in 3 scales	N*
723N	1000—3000	0-12 in one scale	N†

** Also available with UHF, BNC and Type C connectors*
† Also available with BNC and Type C connectors

For more information please write for 68-page catalog No. 12 or see Electronics Buyers' Guide or Electronic Engineers Master.

U.S. Letters Patent No. 2,588,390

M.C. JONES ELECTRONICS CO., Inc.
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Positions are available for men with experience in the following fields: Systems evaluation • Digital computer circuitry • Analog computer instrumentation • Data processing • Microwave design • Pulse circuitry Operations analysis • Advanced mathematics • Electromechanical design • Receiver design • Subminiaturization • Electronic production engineering.

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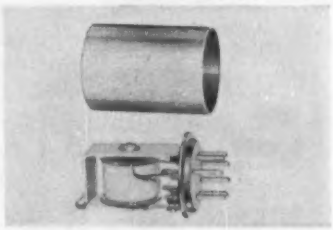
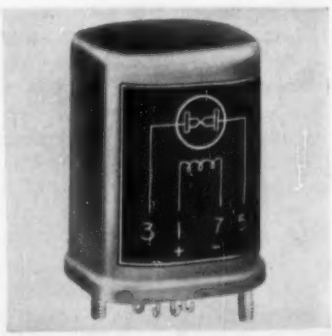
the results in a go-no-go form. The diode may be tested at one voltage for compliance to forward low and high limit current specifications and at another voltage for reverse high limit specifications. A wide variety of test fixtures are available to accommodate various configurations of diodes. **Circle 345 on Reader Service Card.**



Plug-In Relay subminiature

LINE ELECTRIC CO., 271 So. 6th St., Newark 3, N. J. The DF series relay features 7-pin miniature tube base, dust cover, light weight and low cost. Precision designed for extremely long life, it is ideal for computers and radiosonde. Contacts are spdt 2 amperes, 115 v a-c, 60 cps or 26.5 v d-c noninductive. Size is 1 in. above chassis, ¾ in. diameter. **Circle 346 on Reader Service Card.**



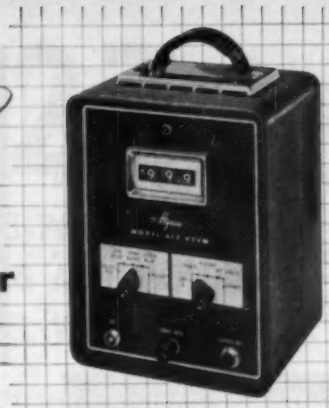
Relay no moving parts

PENDAR, INC., 2664 So. La Cienga Blvd., Los Angeles 34, Calif., has developed an all electronic relay with no moving parts. The electronic coil circuit operates on 28 v d-c, pulls in at 18 v and drops out at 7 v or less with a positive

Hycon

digital volt-ohmmeter

—for quick, easy measurements with consistent accuracy



MODEL 615

Easy to read—the digits are ½" high, white against jet black, and displayed in line for fast, repetitive reading with minimum fatigue.

1% accuracy on DC and Ohms... 2% on AC. The illuminated decimal point and negative polarity indicator insure readout accuracy. And since the display is direct reading, all interpolation and parallax errors are eliminated. Readings are repeated within one digit.

Complete data in Bulletin 615

Model 615.....**$300.00**

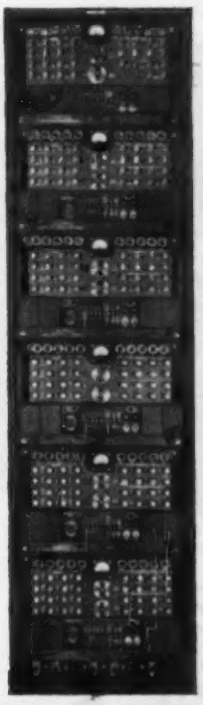
Order from your Hycon representative, or from:

3 DIGITAL INSTRUMENTS IN 1

The Hycon reads DC volts in 4 decimal ranges from .001V to 999V . . . AC volts in 3 decimal ranges from 1.0V to 999VRMS . . . ohms in 5 decimal ranges from 1 ohm to 9.99 megohms.

Hycon ELECTRONICS, INC, 370 So. Fair Oaks, Pasadena, Calif.
A SUBSIDIARY OF HYCON MFG. CO.

CIRCLE 228 READERS SERVICE CARD



MINIATURIZED CARRIER TELEPHONE SYSTEMS FOR RADIO AND 4-WIRE CABLE

FOUR OR 24 CHANNELS

Two miniaturized voice-multiplex systems providing four or 24 voice channels over radio or 4-wire cable are available. They have many advantages over earlier designs: high performance, small size, light weight, low cost, circuit simplicity, low power requirements, small number of tubes of a single type only, low operating cost, low maintenance and high reliability.

These systems provide a voice-channel flat within 1 db from 300 to 3500 cycles, for each 4 kc of bandwidth occupied. Each channel is equipped with hybrid, signalling, and dialling circuits for all the standard 2-wire and 4-wire loop options.

The basic unit provides an order-wire and 4 carrier-derived channels. These units can be stacked in groups of 2, 3, 4 or 5 by means of a group modem to provide 9, 14, 19 or 24 channels. Full flexibility is provided for dropping and inserting channel groups at repeater and terminal points. Moderate lengths of 4-wire cable or open-wire line may be inserted between the multiplex equipment and the radio terminals.

24-channel carrier-telephone terminal complete with hybrids, ringing and dialling circuits, and test facilities. Dimensions are 58" high, 16" wide and 8" deep. Power input 250 watts. Weight 326 lbs.

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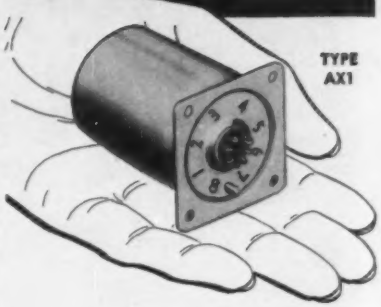
CIRCLE 229 READERS SERVICE CARD

EAGLE

TIME DELAY RELAY



WITH COMPACTNESS — PLUS "MIL-SPEC" 2000 cps VIBRATION TESTS

SPECIFICATIONS (General)

a. Operates during 5 to 2000 cps, 10G vibration.
b. Operates −55° to +125° C.
c. Withstands 30G 11ms shock.
d. Weight 9 oz.
e. Hermetically sealed.
f. D.C. operating coil.
g. Timing not affected by voltage variations.
h. 3% accuracy under normal test conditions.

This relay employs a new type escapement principle. It offers utmost reliability under severe environmental conditions through its rugged design and self-starting characteristics.

Write for complete descriptive Bulletin 820. Address Dept. E-1058.

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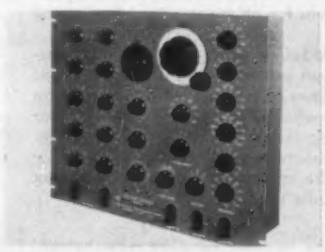
snap action operation. Relay is completely potted and will withstand present day shock or vibration problems. Unit will switch either a-c or d-c, has a transfer time of less than 50 μsec and no contact bounce. **Circle 347 on Reader Service Card.**

Silicon Rectifiers series of ten

Fansteel Metallurgical Corp., North Chicago, Ill., has a series of ten new silicon rectifiers rated at a maximum d-c output current (at 50 C ambient) of 750 ma. Known as type 1N, they are $\frac{1}{8}$ in. diameter by $\frac{1}{2}$ in. long, exclusive of leads. The ten rectifiers are rated in steps from maximum peak reverse voltage of 50 v to 600 v inclusive. Maximum full load forward voltage drop (full cycle average at 150 C) is only $\frac{1}{2}$ v. **Circle 348 on Reader Service Card.**



Vector Bridge direct reading

The Harris Transducer Corp., Woodbury, Conn. Precise direct reading of magnitude and phase angle components of impedance or

at last! AC Microamperes can be measured quickly accurately!

with the NEW QUAN-TECH AC MICROAMMETER
MODEL 301

Saves you time and headaches in making measurements that previously were slow, inaccurate, cumbersome . . . Measures currents in transistors, magnetic amplifiers, resonant circuits, filters, servo systems, recording heads, etc. Using an oscilloscope, observe current waveforms and transient currents.

CLAMP-ON PROBE gives you fast, one-hand operation. Speeds laboratory and production testing.

INSERTION PROBE gives you greater accuracy, increased sensitivity and wider frequency range.

SPECIFICATIONS

SENSITIVITY: 3 μa to 100 ma full scale with Insertion Probe (300 μa to 100 ma with Clamp-On-Probe).

ACCURACY: ±2% of full scale at 1 KC (±5% clamp-on).

FREQUENCY: Flat within ±2% 50~ to 100 KC, —3 db at 10~ and 1 MC (clamp-on ±5% 100~ to 100 KC, —3 db at 50~ and 1 MC).

INPUT IMPEDANCE: 2 ohms plus 8 μh, 60 mmf to ground from 3 μa to 1 MA. Negligible impedance and capacitance 300 μa to 100 MA.

OSCILLOSCOPE CONNECTION: 0.1 volt into 10 K ohms.

PRICE: $290.00 including both probes.

OTHER INSTRUMENTS AVAILABLE:
Miniature DC Coupled Decade Amplifier
Isolation Amplifier
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4027

THE NEW ACME 3-PART MIXTURE FOR IMPREGNATING AND MOLDING ALL ELECTRICAL WINDINGS

Now—an epoxy mixture that comes complete ready to mix and use. Nothing else to buy. Yet the cost is less than what is usually charged elsewhere for the resin alone! That's Acme Star Compound #4027.

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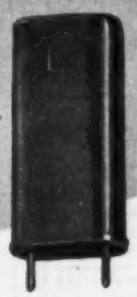
Low Frequency crystals to meet high vibration requirements

Fully tested from 2 to 2,000 CPS vibration. Acceleration of 15 to 30 G's. Frequency range 16 to 100 kc — typical tolerance ± .012% from −40°C to + 70°C. Lower frequencies down to 400 cycles available in other Monitor types with less rigid requirements.

Monitor's modern facilities and techniques insures the quality of all units.



Small size MC-13/U

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"SNIP OR CLIP" TAB TERMINALS

Snip the lead, or clip the tab . . . get the exact terminal type you need! Save space and eliminate the need to stock two types of resistors. This unique feature is on General Electric 5-, 10-, and 20-watt resistors. For your vitreous-enameled resistor catalog, follow reader service instructions below. General Electric Co., Roanoke, Va.

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An analytic treatment of a number of the most commonly used components in servomechanisms and other feedback control systems. Methods of analysis and basic engineering principles are presented from the point of view of the systems engineer, rather than specific discussions of commercial devices. Main emphasis is placed on the calculation of transfer functions. Recent advances in magnetic amplifiers, transistors, and hydraulic and pneumatic systems are covered. *By* JOHN E. GIBSON, *Assoc. Prof. of Electr. Engg., Purdue U., and* FRANZ B. TUTEUR, *Assoc. Prof. of Electr. Engg., Yale University. 480 pp., illus., $12.00.*

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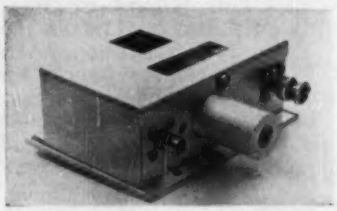
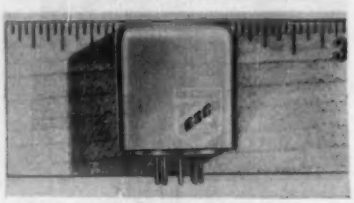
admittance are provided by a new vector bridge useful from 60 cps to low radio frequencies. True bridge circuits insure accuracy dependent only on precision resistors, use no tubes or transistors. Dials displaying ohms impedance and degrees phase angle require no calculations or frequency correction. Range is −90 to +90 deg, impedance up to 100,000 ohms. Accuracies are to a fraction of a percent impedance or fraction of a deg phase angle. **Circle 349 on Reader Service Card.**



Power Amplifier miniaturized

RHEEM MFG. Co., 7777 Industry Ave., Rivera, Calif. A ruggedized, miniature r-f power amplifier measures approximately 5 in. by 3½ in. by 2 in. and weighs only 1 lb. Operating in the 235 mc to the 260 mc telemetering band, the model REL-09 HF delivers an 8-w output to a 52-ohm load with a 1.4-w input drive. Grid and plate tuning controls are accessible from the front plate, and automatic protection is provided against damage resulting from loss of drive or plate power. **Circle 350 on Reader Service Card.**



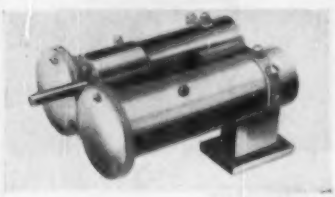
Pulse Generator one-in. square

ESC CORP., 534 Bergen Blvd., Palisades Park, N. J., has developed a new, low cost, portable 1 in. sq pulse generator, the Modupulser. Specified pulse rate is factory-set to

allow for quick, simple plug-in operation. Unit can be supplied with a variable repetition rate. It is also available with external triggering. **Circle 351 on Reader Service Card.**

Megohmmeter self-contained

RADIOMETER, 72 Emdrupvej, Copenhagen NV, Denmark, has announced a new self-contained, line-operated megohmmeter, type IM5, which provides for accurate resistance measurements from 1 megohm to 10^5 megohms in seven ranges. It features 5 fixed d-c test voltages of 50, 100, 200, 500, and 1,000 v that can be used on all resistance ranges. **Circle 352 on Reader Service Card.**



Preselector Filter wide range

AIRTRON, INC., 1096 W. Elizabeth Ave., Linden, N. J., announces a filter especially adapted to broadband image rejection or front-end selectivity applications requiring minimum size and weight. Its two sections provide characteristics simi-

MARCONI

TEST SETS FOR MOBILE RADIO TESTING

Designed for precision performance in

- ✻ ***Receiver alignment***
- ✻ ***Signal-to-noise measurement***
- ✻ ***Discriminator testing***
- ✻ ***Checking rf and audio outputs***
- ✻ ***Deviation measurement***

. . . All you need for fast field testing of fm transmitters and receivers is here in these two complementary instruments, tailored for mobile radio measurements.

The 1064/2 provides high-grade fm outputs in the ranges 30 to 50, 118 to 185, and 450 to 470 mc; crystal-controlled i-f outputs at five spot frequencies; and a 1 kc af output.

The 1065 has an rf power meter and 0-15 kc deviation indicator for use up to 500 mc; a dual-impedance af power meter; and a multi-range volt/ammeter.

Each is lightweight, portable, and quality-engineered throughout. Tubes and crystals are all American types. Send for leaflet B117/B.

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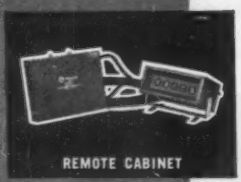
Speeds reading

DIRECT reading digital converter fits all vertical DCU system counters — no wiring changes, no plug-in connections or mechanical modifications required.


REMOTE CABINET

DIGIVERTER clamps on front panel of counter over vertical windows; has self-contained power supply with line cord for 115-volt, 50-2400 cycle outlet; uses less than one watt per DCU. Its photoelectronic system transmits directly whatever the counter reads without interference; no relays, vacuum tubes, thyratrons, or transistors are used. Utmost simplicity results in greatest reliability.

REMOTE PANEL

DIGIVERTERS are available with Nixies® mounted on converter case for integral readout (as illustrated above) or with Nixies® in a separate housing or on a standard relay rack panel for remote reading (as shown at left).

DIGITAL converters for individual DCU's are also available for OEM installation, customizing or installation in special purpose test equipment and computers where "in-line" display is desirable. These are called DIGIDECS and can be supplied for either integral or remote reading.

* ***WHY TRAIN PERSONNEL . . .***
to random display when "in-line" reading is the natural way.

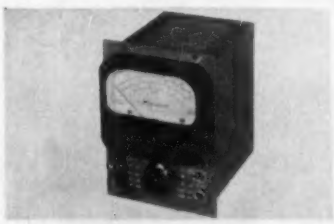
SEND FOR TECH. DATA
For additional information, including application data, write or phone DE 4-3100. Demonstrations available by local representatives.

Radio Frequency
LABORATORIES, INC.
Boonton, New Jersey, U. S. A.

lar to those of a standard four-section filter. Use of two TE_{111} modes in each section has the further advantage of a broad tuning range free from crossing or interfering modes. Unit shown on p 163 tunes from 7,500 to 8,500 mc, with insertion loss not exceeding 2.0 db for a 25 mc bandwidth. Rejection obtained from these characteristics is at least 50 db at frequencies 60 mc removed from F_o. **Circle 353 on Reader Sevice Card.**

Edgewise Meter
compact, rugged

MARION ELECTRICAL INSTRUMENT CO., Grenier Field, Manchester, N. H. The MCE-1 edgewise meter is designed for control panel applications where space is limited but large display is required. It features a clear Plexiglas front and large triangular pointer that is easily seen on a scale $1\frac{7}{8}$ in. long. They are available in standard current and voltage ranges (100 ma to 1 ampere and 1 to 300 v.) **Circle 354 on Reader Service Card.**



Voltmeter
panel mount type

WAVEFORMS, INC., 331 Sixth Ave., New York 14, N. Y. Model 520A-P AC amplifier/voltmeter mounts interchangeably with the 510B-P panel mount audio oscillator. It is assembled on an oversize panel which serves as mounting plate and escutcheon. It bolts to any panel

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NEW miniature rotary switch

TYPE **MA-12**

12 POSITIONS
5 SECTIONS
3 AMP.
115 V.
A-C

ACTUAL SIZE

FEATURES:

- **Small** — ¾" square
- **Versatile** — up to 6 poles per section; up to 5 sections
- **Current-carrying capacity** — 3 amp.
- **Interrupting rating** — ½ amp. 115 v. a-c.
- **Voltage breakdown** — 1000 volts RMS
- **Rotation** — unlimited, or limited 2 to 12 pos.
- **Electrical life** — 10,000 cycles at rated load
- Designed to meet MIL-S-3786

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DIVISION OF ELECTRO SWITCH CORPORATION
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Shown Actual Size

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The Model 106 has proven incomparable for speed and accuracy . . . yet reasonably priced.

Cutter grinders, rotary tables, master letters, compound slides, name plates and all required accessories. For complete information, write to

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- Unobstructed on three sides to take large work
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- Vertical range over 10"

GREEN INSTRUMENT COMPANY, INC.

363 PUTNAM AVENUE, CAMBRIDGE 39, MASS.

CIRCLE 242 READERS SERVICE CARD

AMCI TYPE 1026 SLOTTED LINES

for accurate measurement of impedance in rigid and flexible coaxial transmission lines.

FEATURES:

- **Rated residual VSWR under 1.01**
- **Rated error in detected signal under 1.005**
- **Available in 20, 40, 60, 80, and 130 inch lengths.**

Write for Bulletin E-958

The outer conductor of the Type 1026 Slotted Lines is made of two substantial aluminum castings, carefully machined and dowelled together, with the important surfaces finished by a hand scraping operation. The inner conductor is ground to a close tolerance, supported by compensated dielectric pins, and longitudinally positioned by a compensated dielectric anchor at the feed end.

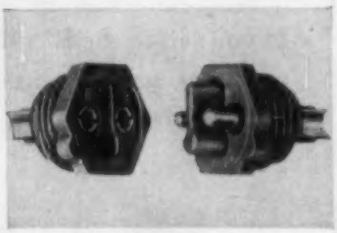
AMCI Tapered Reducers, Instrument Loads, and Impedance Standard Lines are available for use with the Type 1026 Slotted Lines in making measurements of a wide range of rigid and flexible coaxial lines.

ANTENNA SYSTEMS – COMPONENTS – AIR NAVIGATION AIDS – INSTRUMENTS

AMCI **ALFORD** *Manufacturing Co. Inc.*

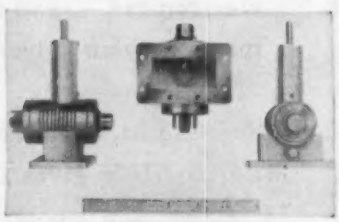
399 ATLANTIC AVE. BOSTON, MASS

with a 6⅞ in. by 4⅛ in. cutout. Unit has 12 ranges in 1-3 sequence from 0.001 v to 300 v full scale. Input impedance is 10 megohms and band-pass is 10 cps to 2 mc. **Circle 355 on Reader Service Card.**



Connector hexagonal type

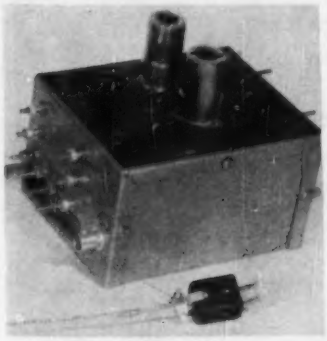
DEJUR-AMSCO CORP., 45-01 Northern Blvd., Long Island City 1, N. Y. A new miniature, hexagonal, two-contact connector is suitable for high altitude applications requiring high breakdown voltages under critical environmental conditions. A polarizing barrier between the two pin contact is an integral part of the low arc resistance Melamine molding MIL-M-14E, type MME mineral filled. The barrier provides a long leakage path and permits use of high voltage (4,000 v rms) and current (30 amperes) without breakdown. **Circle 356 on Reader Service Card.**



Reflex Klystrons for C-band

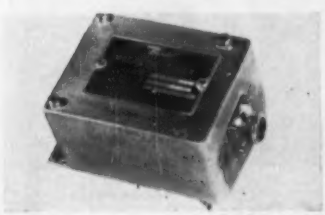
EITEL-MCCULLOUGH, INC., San Bruno, Calif., has introduced two new C-band reflex klystrons, the 1K125 series. These ceramic-metal tubes cover the frequency range of 3,700 to 5,000 mc. Capable of output powers to 2.3 w, they are ideal for reliable broadband point-to-point communications use. They are tuned by an adjustable dielec-

tric slug rather than a variable r-f gap, thus minimizing sensitivity to shock and vibration. Higher temperature ratings made possible by the use of ceramics, and an integral-finned cooler, keep cooling requirements at a minimum. **Circle 357 on Reader Service Card.**



Preamplifier
general purpose

ARENBERG ULTRASONIC LABORATORY, INC., 94 Green St., Jamaica Plain 30, Mass., announces the PA-620 preamplifier which makes available at the ultrasonic transducer output a tuning coil that will resonate at all frequencies from 6-70 mc with the fixed capacity of the crystals which may reach 100 $\mu\mu$f in ultrasonic work. A second objective is to narrow the pass band and improve the signal to noise ratio. A third is to provide a light weight pickup head which may be placed more conveniently close to the object being tested. A fourth objective is to provide means for varying the bandwidth. **Circle 358 on Reader Service Card.**



Magnetic Timer
no moving parts

BENDIX AVIATION CORP., South Bend 20, Ind. Solid-state compo-

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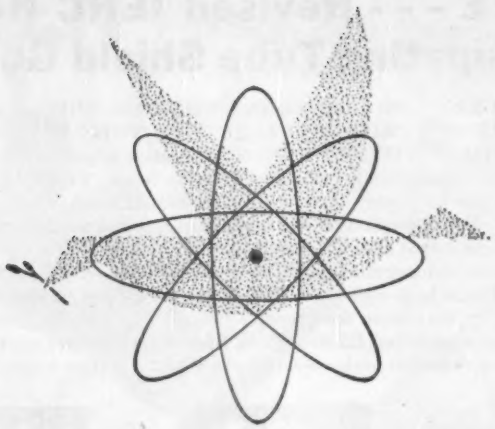
Heat-dissipating electron tube shields for miniature, subminiature and octal/power tubes.



performance for PEACE

More than sixty Los Alamos scientists were invited to Switzerland by the United Nations to participate in the 1958 International Conference on Peaceful Uses of Atomic Energy. Five major experimental devices, designed at Los Alamos, were set up at Geneva and exhibited in operation.

This international prestige of the Los Alamos Scientific Laboratory has been well earned by the members of its staff, an informal and creative community of scientists and engineers.

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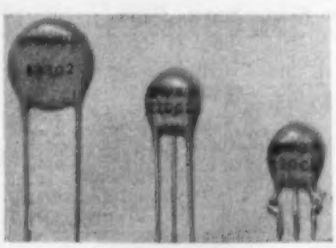
ents such as transistors, diodes and special magnetic amplifiers have been combined to develop a magnetic timer with no moving parts. The design, which is suitable for use on most rocket engines, will provide an accurate timed interval of a few millisec to several seconds. Small in size, the timer is claimed to be rugged, accurate, versatile and reliable. **Circle 359 on Reader Service Card.**

Tiny Servomotor simplified design

DYNAMIC INSTRUMENT CORP., 59 New York Ave., Westbury, L. I., N. Y., announces the model M-100 60-cycle BuOrd Size 11 frame miniature servo motor. Its simplified coil and stator assembly permit manufacture of practical miniature motors as small as 3/10 in. diameter. The M-100 can be provided with a variety of shaft extensions, power and voltage ratings. **Circle 360 on Reader Service Card.**



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New Exclusive
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Saves: Production Costs

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Corrects: for Non-uniformity of torque in phenolic impregnated coil forms

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- ★ Equalizes initial and running torque
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STABILITY less than 0.005 μsec. jitter & 0.005% change in delay with change in prf.

VERSATILITY single or paired pulse output & delayed scope trigger in advance of delayed pulse.

EXTERNALLY TRIGGERED

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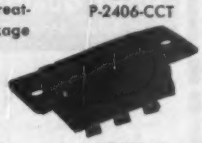
- Interchangeable with 400 Series.

P-2406-CCT



S-2406-SB

Send for complete Catalog No. 22, Plugs, Sockets, Terminal Strips.

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CINCH MANUFACTURING CORPORATION
CHICAGO 24, ILLINOIS
SUBSIDIARY OF UNITED-CARR FASTENER CORP.

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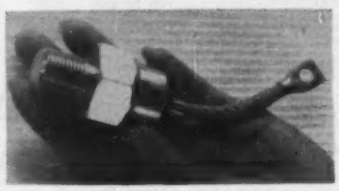
tions where previously rectangular plates had to be used. The small printed circuits can be handled, inspected, inserted and soldered in your plant using exactly the same techniques that were employed for disk ceramic capacitors. The company has solved the problem of screening resistors on the same disks previously used for single and multiple capacitors without the necessity of notching or perforating the disks in order to maintain alignment of screen patterns during manufacture. **Circle 361 on Reader Service Card.**



Silicon Rectifier for power uses

WESTINGHOUSE ELECTRIC CORP., P.O. Box 2099, Pittsburgh 30, Pa. Type 329 silicon power rectifier can provide average forward currents up to 160 amperes per cell in single-phase circuits or 150 amperes per cell in three-phase circuits with maximum peak inverse ratings up to 500 v. Features include: high ambient temperature operation—up to 190 C junction temperature; long life; high efficiency; low regulation; rugged construction and small size. **Circle 362 on Reader Service Card.**

Precision Switch sub-subminiature

MICROSWITCH, Freeport, Ill. The type SX sub-subminiature precision snap-action switch measures only 0.5 by 0.35 by 0.2 in. (on the case)

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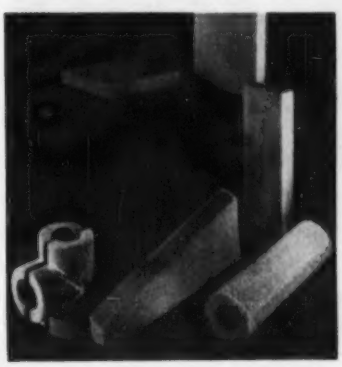
and weighs but ¼ oz. Electrical rating is 5 amperes at 250 v a-c and 30 v d-c. An important space-saving feature is the small stacking area which it requires when ganged on common mounting pins. Ten switches can be mounted in every sq in. of space. Contact arrangement of the SX is spdt. Operating force is 6 oz maximum, release force 1 oz minimum. **Circle 363 on Reader Service Card.**

TWT Amplifier
low noise

LEL, Inc., 380 Oak St., Copiague, L. I., N. Y. Model TWT-10 CM traveling wave amplifier features helix protection through incorporation of a high sensitivity relay circuit. Noise figures of less than 7 db over a wide band of frequencies, combined with protection against crystal burnout are some of the advantages obtained by the use of these amplifiers in radar systems. **Circle 364 on Reader Service Card.**

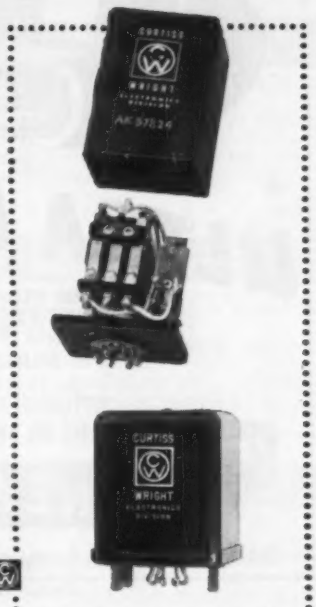


Insulating Material
wide range of uses

Pittsburgh Corning Corp., One Gateway Center, Pittsburgh 22, Pa., has developed an acid-resistant insulating and refractory material

Double-throw contacts, fast reset
THERMAL TIME DELAY RELAYS
"MR" and "CR" Series..no chatter

- **Time delays — 3 to 60 seconds**
- **"MR" for military use — withstands 5-500 cps. Form C contacts — input voltage, 28, DC, ambient −65°C. to +125°C.**
- **"CR" for machine tool requirements — withstands 5-55 cps. Two Form C contacts — input voltages, 28 and 117, AC or DC, ambient temperature −55°C. to +85°C.**



The **"MR"** and **"CR"** relays are part of the new Curtiss-Wright Thermal Time Delay Relay line which includes:

H-Series
— vibration resistant, for missiles, aircraft
S-Snapper
— double-throw, snap-action contacts
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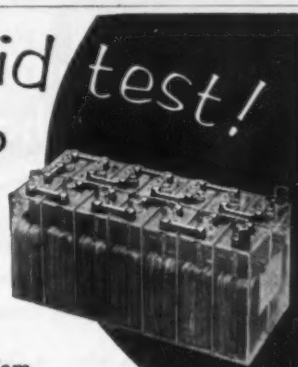

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C 11	6.3	173	.36"
C 2	6.3	171	.44"
C 22	5.5	184	.44"
C 3	5.4	197	.64"
C 33	4.8	220	.64"
C 4	4.6	229	1.03"
C 44	4.1	252	1.03"

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For AEROPAK ceramic insulated wire—Bulletin 4

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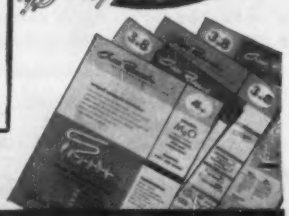

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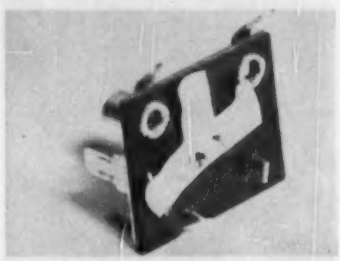

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S-60	1/5 sec.	60 min.	±.1 sec.
SM-60	1/100 min.	60 min.	±.002 min.
S-10	1/10 sec.	1000 sec.	±.02 sec.
S-6	1/1000 min.	10 min.	±.0002 min
S-1	1/100 sec.	60 sec.	±.01 sec.
MST	1/1000 sec.	.360 sec.	±.001 sec.
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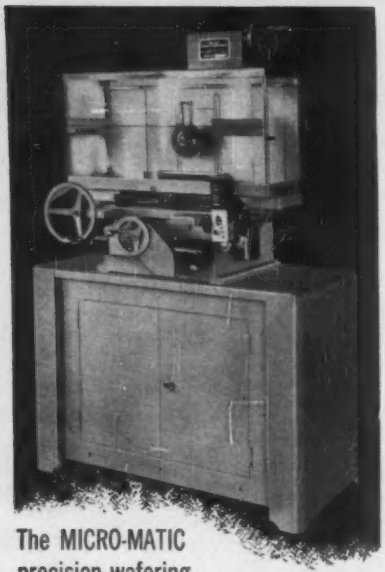

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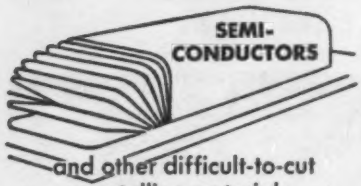

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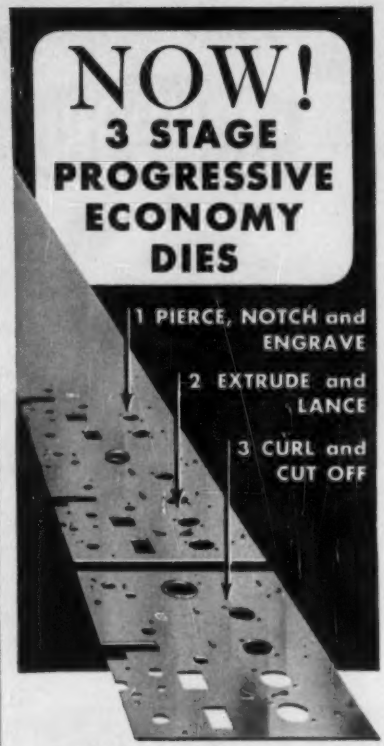

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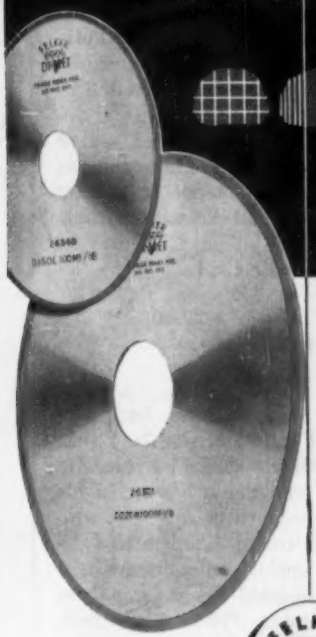

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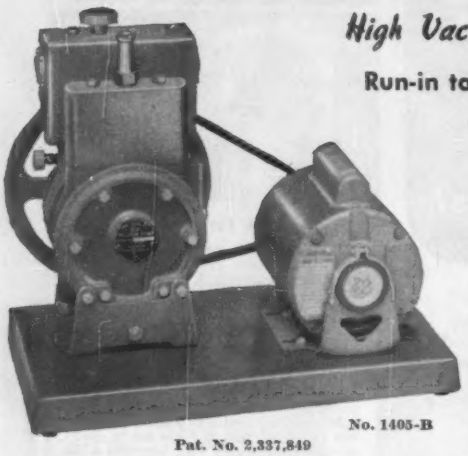

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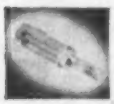

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Epoxy Casting System. Isochem Resins Corp., 221 Oak St., Providence 9, R. I. Technical data bulletin DB-405-8167 covers Isocast 405, a general purpose 100 percent solids, filled epoxy resin casting system which may be used over a wide temperature range. **Circle 375 on Reader Service Card.**

Wire Markers. North Shore Nameplate, Inc., 214-27 Northern Blvd., Bayside 61, N. Y. An 8-page catalog illustrates and describes a wide variety of standard Speedy-Marx wire markers available on instant-release dispensing cards. **Circle 376 on Reader Service Card.**

COMPONENTS

High Temperature Switch. Micro Switch, Freeport, Ill. Data sheet 140 describes a new switch, said to have the highest available electrical rating for its size of any switch designed for use at 600 F. Case, cover and plunger of the device discussed are molded of a special type of glass-bonded synthetic mica. Operating characteristics, electrical data and prices are covered. **Circle 377 on Reader Service Card.**

P-C Connectors. H. H. Buggie, Inc., P.O. Box 817, Toledo 1, Ohio. A 24-page catalog describes and illustrates a standard series of printed circuit connectors, and lists many variables that have been designed and produced for specific applications. **Circle 378 on Reader Service Card.**

R-F Filters. Microphase Corp., Box 1166, Greenwich, Conn. Catalog C3-58 lists a number of standard low-pass and high-pass filters of the block, tubular and shell types operating in ranges from 10 mc to 12,000 mc. **Circle 379 on Reader Service Card.**

Silicon Semiconductors. Hoffman Electronics Corp., 930 Pitner Ave., Evanston, Ill. A 6-page folder

the Week

contains technical data on general purpose diodes, glass diodes, zener diodes, rectifiers, zener reference units, zener power regulators and solar cells. **Circle 380 on Reader Service Card.**

EQUIPMENT

Diode Tester. Technitrol Engineering Co., 1951 E. Allegheny Ave., Philadelphia 34, Pa. A two-page folder covers the operating principles of the model 1001 dynamic diode tester and explains the type of diode characteristics which can be analyzed, such as forward and back resistance, hysteresis and stability. **Circle 381 on Reader Service Card.**

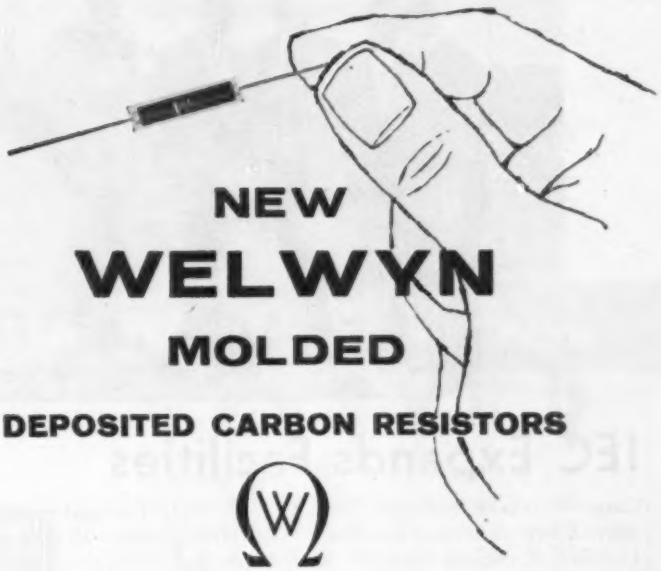
Magnetic Voltage Regulators. Sorensen & Co., Inc., Richards Ave., South Norwalk, Conn. A 4-page illustrated brochure furnishes complete technical data on the MVR magnetic voltage regulators. It covers detailed product description, principles of operation, operating instructions and maintenance. **Circle 382 on Reader Service Card.**

Multichannel Sampling. General Devices, Inc., P. O. Box 253, Princeton, N. J., announces a 16-page booklet on electronic and electromechanical sampling devices for multichannel instrumentation. It contains more than 35 illustrations on the subject of selection and application of sampling devices. Booklet may be obtained by a request on company letterhead.

FACILITIES

Facilities Brochure. Automation Dynamics Corp., 255 County Road, Tenafly, N. J. A four-page brochure describes services offered for development and construction of electronic equipment for measurement, communication, computing and control. A brief outline of the facilities and thumbnail sketches of the technical leaders are presented. **Circle 383 on Reader Service Card.**

REDUCE
BREAKDOWN FAILURES



NEW
WELWYN
MOLDED
DEPOSITED CARBON RESISTORS

The use of a thermo-plastic insulation material has resulted in an economically priced molded carbon resistor of markedly improved endurance and long term stability.

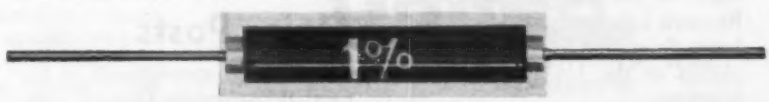
Type N resistors subjected to several one-hour cycles of immersion in boiling water — while DC polarized — have revealed only negligible changes in resistance. Continuous operations at 150°C caused no damage to the component.

The new Type N resistor, a deposited carbon film fired onto a porcelain rod, is first tropicalized with multiple coatings of panclimatic lacquers to give it long term moisture resistance, and is then molded in a thermo-plastic material.

This molded insulation has an effective resistance in the order of 10^{13} ohms. Its inherent thermal conductivity is approximately ten times that of air, resulting in substantially improved load life under conditions involving excessive or high wattage dissipation. Similarly, Type N resistors may be soldered as close to the insulation as desired without fear of melting or deforming the cover.

One added advantage of the Type N is that the original markings on the resistor body remain visible and legible through the transparent molded material.

Welwyn Type N carbon resistors meet the requirements specified by MIL-R-10509B, and are available in all values, ranging from 10 ohms through 1 megohm. For complete data and specifications write to Welwyn International, Inc., 3355 Edgecliff Terrace, Cleveland 11, Ohio.



SAMPLES AVAILABLE ON REQUEST.

IEC Expands Facilities

GROUND-BREAKING ceremonies were recently held to initiate work on a 15,000-sq ft engineering office for Interstate Electronics Corp. of Anaheim, Calif.

This new addition will increase the company's total floor area from 56,000 to 71,000 sq ft of engineering, manufacturing and office space. It supplements the existing facilities, which include an electronic engineering laboratory, a technical library and an instrument calibration laboratory.

Headed by Paul H. Reedy, president (shown at left with, l to r, Frank E. Booth, vice chairman of board; L. Delford Fedderman, chairman of board; Charles A. Pearson, Anaheim mayor; John E. Koster, board member), the firm has enjoyed a rapid growth.

Inaugurated with three people in January 1956, the company now employs more than 270, and has a current backlog of over $4 million.

Interstate Electronics is engaged in the field of advanced communications and missile test range instrumentation, and is a prime contractor for Polaris fleet ballistic missile instrumentation.

Augmenting the firm's electronic engineering endeavors are two new departments: Aeronautics, directed by Frank G. Denison, and Television, directed by James J. Reeves. An intensive R&D program has been initiated in the field of specialized closed-circuit tv with unique medical adaptations.

Honor British Scientists

THREE British scientists will receive John Price Wetherill Medals from The Franklin Institute of Philadelphia at Institute ceremonies next Wednesday.

Slated for the awards are John T. Randall, Wheatstone professor of physics at the University of London, King's College; Henry A. H. Boot, a senior principal scientific officer at the Services Electronics Research Laboratory, Baldock; and James Sayers, professor of electron physics at the University of Birmingham.

Medal citations to the three scientists read: "For their basic developments which provided the first useful highpower pulsed microwave magnetron, and which established the fundamental principles upon which all later developments in this field were based."

CEC Fills Three Major Posts

THREE major appointments in the Central Engineering Division, Consolidated Electrodynamics Corp., Pasadena, Calif., were recently announced by Joseph H. Lancor, Jr., vice president in charge of development.

Francis T. Greenup, formerly chief product engineer, is named manager of engineering services and manager of the Alectra Department, which designs and manufactures CEC's Alectra line of portable test instruments.

George M. Slocomb is promoted from supervisory principal engineer to assistant chief development engineer.

E. James Penrose is named administrative manager. He was formerly assistant to Lancor.

Nolan Takes New Position

THE Pacific Division of Bendix Aviation Corp., N. Hollywood, Calif., has appointed Edward L. Nolan as radar applications engineer with responsibility for sales promotion of the company's line of airborne radar for the military. With the company since 1951, Nolan has headed the applications and field engineering group in radar engineering for the past two years.

Burton Moves To Avco's RAD

APPOINTMENT of Charles J. Burton as vice president is announced by Avco Research and Advanced Development Division. He moves to Avco RAD from Barnes Engineer-

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Simplify design
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Save money

You can save many expensive engineering hours because designers no longer need to plow through thousands of eyelet specifications. Over 20 years' experience has shown that a very high percentage of all eyelet work can be done with the 7 United Standard diameters.

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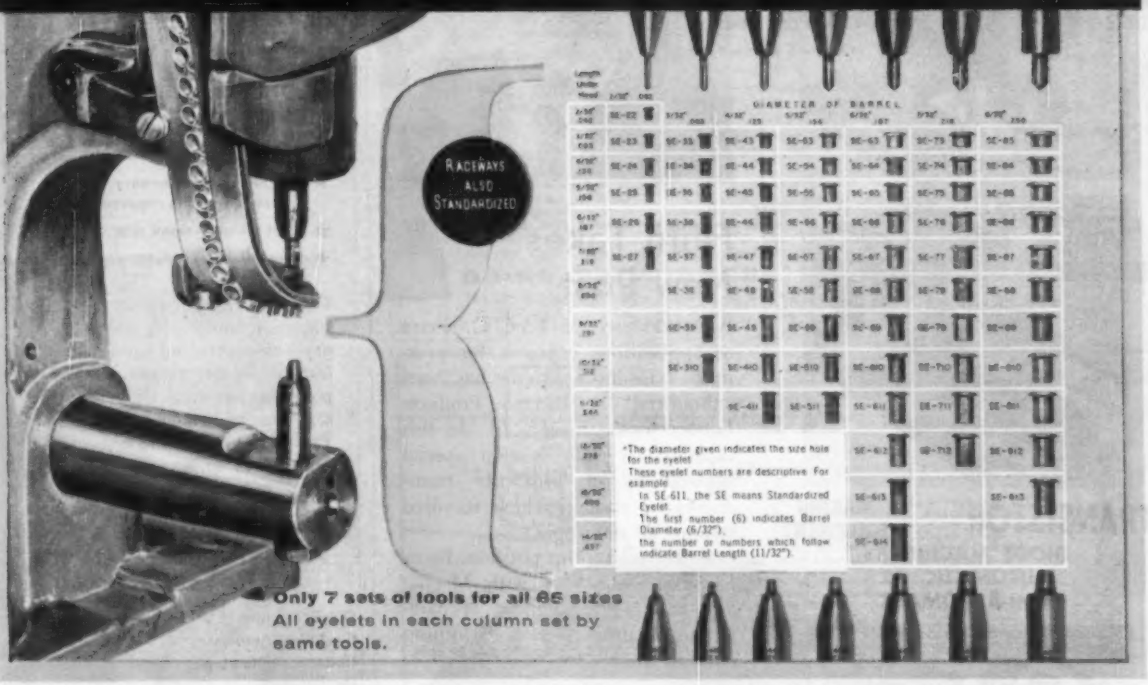
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DIAMETER OF BARREL
*The diameter given indicates the size hole for the eyelet
These eyelet numbers are descriptive. For example
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The first number (6) indicates Barrel Diameter (6/32").
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Only 7 sets of tools for all 65 sizes
All eyelets in each column set by same tools.

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Inventory is greatly simplified. Fewer sizes do more jobs. Actual experience of thousands of users for over two decades has shown that United Standardized Eyelets and co-ordinated Eyeleting machines can reduce the number of eyelet sizes carried in stock an average of 66⅔%.

Precision made in standard increments of 1/32" in both barrel O.D. and length, each one of the 65 United Standardized Eyelet sizes has a standard relationship in dimension and proportion to every other eyelet in the series. They are designed to save you money. Start to-day to enjoy the advantages of United's Standardized Eyelets. Write or call us for complete information.

New Eyelet Catalog Complete specifications of all phases of United's co-ordinated system of eyelets, eyeleting machines, setting tools. Also includes data on special eyelets and metal stampings.

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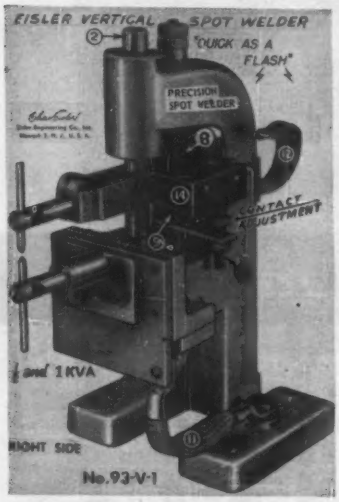

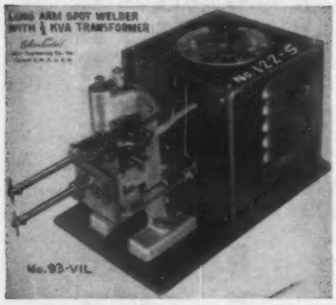

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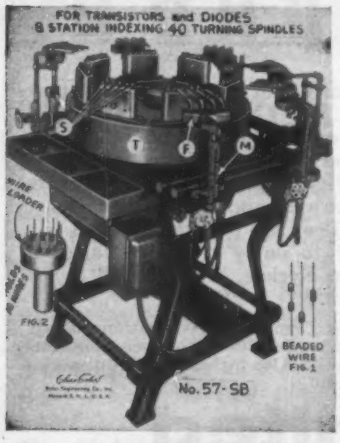

Send for Catalog Dr. Chas. Eisler, M. E. Founder
CHAS. EISLER, JR., *PRES.*

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ing Co., where he was vice president since 1952. Previously, he had been with American Optical and American Cyanamid.

Burton specializes in electron microscopy and ultrasonics, is working at Avco RAD's new center in Wilmington, Mass.

Feirn Takes New Post

APPOINTMENT of Fred C. Feirn as applications engineer for proximity transducer systems has been announced by Electro Products Laboratories, Chicago, Ill. In this capacity he will develop special applications of proximity transducers for uses in which standard systems do not apply.

Before taking this position, Feirn had been associated with Magnaflux in the development of magnetic circuitry for determining flaws in metals.

IRE's PGME Names Two

E. A. SPEAKMAN, manager of planning, RCA Defense Electronic Products, Camden, N. J., has been named chairman of the administrative committee, Professional Group on Military Electronics, IRE.

R. R. Welsh, manager of the Camden office of RCA's West Coast Electronic Products Department, becomes committee secretary.

Speakman and Welsh succeed, respectively, Willis E. Cleaves of

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Output Frequency	**400 CPS**
Frequency Accuracy	**± 0.002%**
Under the following conditions:	
temperature	**0 to +60°C**
voltage variation	**25 to 30 VDC**
vibration	**0 to 2000 CPS @ 10G**
Output Power	**50 Milliwatts**
Output Impedance	**80 Ohms**
Input Voltage	**28 Volts DC**
Input Power	**1 Watt**
Heater Voltage	**28 Volts DC**
Heater Power	**3 Watts DC**
Size	**4½" long x 1¾" diameter**
Weight	**11 Ounces**

Write for data sheet or information on your specific requirements.

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Bendix Aviation, Towson, Md., and Carl R. Busch, Aeronautical Radio, Inc., Washington, D. C.

The professional group on military electronics reports periodically to the general IRE membership on conditions within the military electronics industry.

Both Speakman and Welsh were appointed for one-year terms.

Microsonics, Inc., Hires Federico

NEW ADDITION to the engineering staff of Microsonics, Inc., Hingham, Mass., is Gennaro S. Federico. He will work on ultrasonic solid delay line design and development.

Federico was formerly a senior engineer on prototype research for the Corning Glass Works.

Jordan Joins Gulton Industries

APPOINTMENT of J. Paul Jordan as assistant to the president of Gulton Industries, Inc., Metuchen, N. J., is announced. He joins the company in the capacity of a scientific coordinator, responsible for technical planning on government and company sponsored programs.

During his employment with General Electric Co., over the past 20 years, Jordan specialized in electronics and physics and served as

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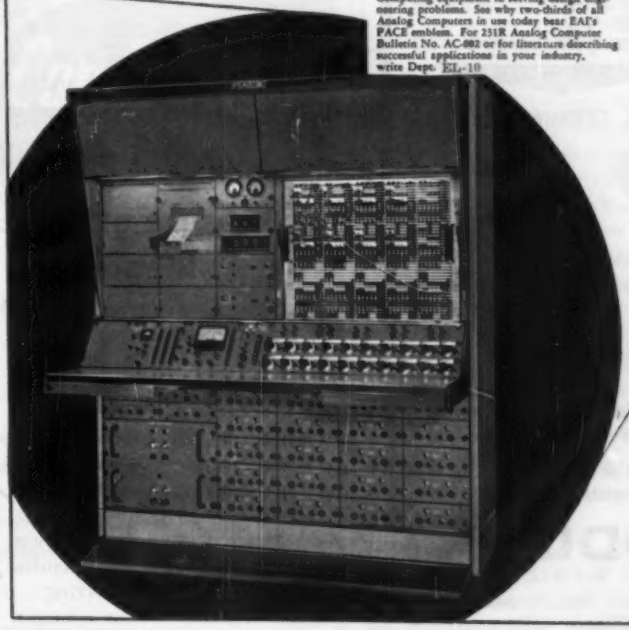

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Characteristic Impedance: 50 ohms.
Attenuation Value: Any value from 0 db to 60 db including fractional values.
Accuracy: ±0.5 db; values above 50 db have rated accuracy of attenuation through 1000 mc only.
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a consulting engineer; manager, Physical Electronics Section; section engineer and special assignments engineer.

Garcelon Joins El-Tronics, Inc.

CONTINUING its management building program, made necessary by acquiring three companies in the past 18 months, El-Tronics, Inc. has appointed Fred H. Garcelon to the position of executive vice president.

Garcelon comes to El-Tronics after 9 years with CBS-Hytron where he was general sales manager of transistor operations.

Located in El-Tronics' executive offices in Philadelphia, his duties will embrace all company divisions: Alwac Computer Division, Los Angeles, Calif.; Warren Component Division, Warren, Pa.; and the Parkchester Machine Division, Mayfield, Pa.

RCA Appoints New Managers

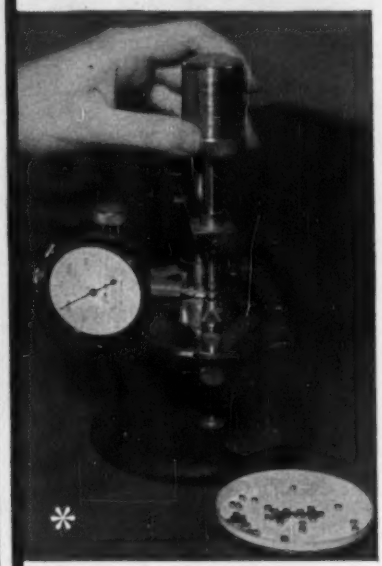
THE ENGINEERING department of the RCA Semiconductor and Materials Division has announced three appointments.

B.V. Dale, who was chief engineer of the former RCA Components Division, has been named manager, Modules Engineering.

F.E. Vinal, previously manager, RCA Materials Advanced Development Laboratory, was appointed manager, Materials Engineering.

D.H. Wamsley, former manager,

There's a *Bird*
JEWEL BEARING
to fit Your Need!



Bird can supply you with sapphire and borosilicate glass precision jewel bearings in a wide range of standard types, sizes, and complete assemblies — or, custom-built to your specifications. Special mounting techniques provide exact tolerance jewel assemblies, mounted or set in bushings or screws, ready for assembling into your product without further inspection. Jewels mounted with resilient silicone rubber or spring cushions provide additional protection to shock and vibration.

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Ferrites are the finest material for tuning slugs wherever a high-Q, high-permeability core is required and space is at a premium. These Ferroxcube tuning slugs have been specifically developed for the permeability tuning of inductors, filters and transformers in the 1 kc to 4 Mc frequency range. They come in a large variety of sizes and threads, and have been found particularly useful for final inductance adjustments on filters with ferrite pot cores. The screwdriver slot in the slugs runs all the way through the core for simpler coil assembly and easy adjustability at either end. All Ferroxcube threaded slugs are furnished complete with self-threading coil forms of phenolic-impregnated tubing.

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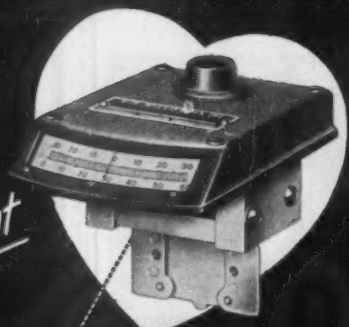

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Announcing...
Modine transistor coolers

Standardized for immediate shipment in module and strip form

These compact, lightweight aluminum units prevent thermal runaway in electronic circuits . . . hold transistor junction temperature safely within design limits. Heat is conducted through the base mounting plate and is dissipated by cooling air passing through the fins.

Modine Bulletin ID-158 contains performance data and application information on these efficient coolers. For full details on standard and custom-built models, write Electronic Cooling Dept., Modine Manufacturing Co., 1602 DeKoven Avenue, Racine, Wisconsin.

Modine MANUFACTURING COMPANY

T-1373

Engineering Department, becomes manager, Semiconductor Engineering.

Dale and Wamsley will have their headquarters at the Somerville, N.J., plant. Vinal will remain at the RCA facility in Needham Heights, Mass.

News of Reps

GPL closed-circuit tv equipment is now being handled in Colorado, Utah and Wyoming by the **Paul R. Posakony Co.**

DeJur-Amsco Corp. has appointed the following sales reps:

Logan and Stone Co. to cover the northern California territory; **Jerry Deere Associates** for the states of Utah, Colorado, New Mexico and Arizona.

Gene French Co. is named to carry the electronic instrument line of Belleville-Hexem Corp., Los Gatos, Calif., in New Mexico, Colorado, Utah and parts of southern Nevada and northwest Texas.

Appointment of the **Merrill Franklin Co.** as sales reps in Minnesota, North Dakota, South Dakota, and the western part of Wisconsin, is announced by Deltime, Inc., Mamaroneck, N. Y.

Electro Tec Corp., South Hackensack, N. J., has two new reps:

Northport Engineering, Inc., will handle sales in Minnesota, North Dakota, South Dakota, Wisconsin, counties of Bayfield, Sawyer, Rusk, Chippewa, Eau Claire, Trempealeau and La Crosse and all west of these.

The Hilker Co. will cover North Carolina, South Carolina, Georgia, Kentucky, Tennessee, Alabama and Mississippi.

Computer Engineering Associates, Inc., Pasadena, Calif., appoints **Landfear Enterprises** as reps for New York State, south of Kingston, and for northern New Jersey.

Seezak components of U. M. & F. Mfg. Co., North Hollywood, Calif., will be sold in southern California and Arizona by **Pacific Electro-Sales, Inc.**

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1. Balanced rotary element with radial thrust bearings at both ends of shaft, operated by the balanced pull of twin coils — minimizes effect of gravity, shock and vibration, permitting reliable operation where other relays fail.

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NEW BOOKS

Network Synthesis

By D. F. TUTTLE, JR.

John Wiley and Sons Inc., New York. 1958, 1,175 p, $23.50.

THE most significant single fact about this huge volume on network synthesis is the care taken by the author in providing an impressive treatment of concepts relating to the synthesis of two-terminal networks. His able and straightforward discussions of many topics are neatly integrated into a provocative account of the evolution of modern network theory.

Although this initial volume stresses only the two-terminal network, many fundamental ideas are presented germane to the synthesis of four-terminal networks which the author plans to develop as a second volume later on.

Background—The book is admirably suited for the designer of low-frequency electrical networks of the linear passive bilateral variety. Before the middle twenties, the designer relied solely upon the laws of Kirchhoff to yield important information on the behavior of linear networks. These laws, first published in 1845, provided a basic mathematical approach to the problem of network analysis and led to the concept of complex impedance. In the middle twenties, synthesis ideas began to emerge through the early efforts of G. A. Campbell, R. M. Foster, and W. Cauer. The added stimulus came from Otto Brune who in 1930 supplied the concept of physical realizability and sparked the development of network synthesis as a direct approach to the design of networks to meet prescribed conditions.

Basically, the book is intended as reference material for a first-year graduate course. In a nicely balanced arrangement, the 15 chapters fall into three general areas of consideration; analysis and mathematical formulations, introducing the reader to the complex-frequency variable and positive-real functions; properties of driving-point impedances and procedures for synthesizing R-L, L-C, R-C and RLC structures; the approximation problem with emphasis on the potential

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Three-Phase Half Wave (3 Tubes)	4710‡	4780	.75
Three-Phase Double Y-Parallel (6 Tubes)	4080‡	4780	1.5
Three-Phase Full Wave (6 Tubes)	4080‡	9570	.75

*per tube †total ‡per leg

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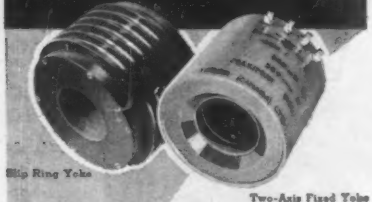

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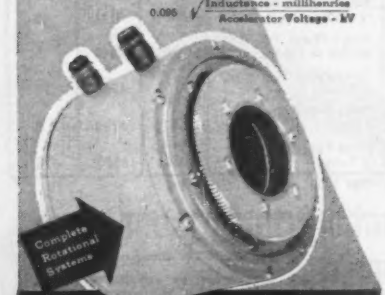

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analogy. Each chapter is thoroughly documented and meticulously detailed with a wealth of illustrative examples and problems.

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Since driving-point immittance functions of passive structures are necessarily rational and positive-real, the fifth chapter concentrates on necessary properties for physical reality. In the sixth chapter, the synthesis of L-C functions is developed from the separation property of poles and zeros along the imaginary axis of the complex frequency plane. By means of partial fraction and continued fraction expansions, canonic networks are evaluated. The technique is extended to R-C and R-L functions in the seventh chapter.

Three extensive chapters follow on additional properties of RLC functions and on a general synthesis procedure which relies upon the removal of reactance, susceptance, resistance and conductance along the real frequency axis of the complex frequency plane as preliminary steps in achieving a final synthesis. These steps are accomplished by a procedure which assures that the reduced function remains positive-real throughout the process. A special point is made of the fact that the real part and the imaginary part of a reduced driving-point immittance are interrelated. Various methods are then presented which yield a final synthesis. These are based upon contributions by Brune and Darlington involving perfectly coupled coils and contributions by Bott and Duffin which lead to a

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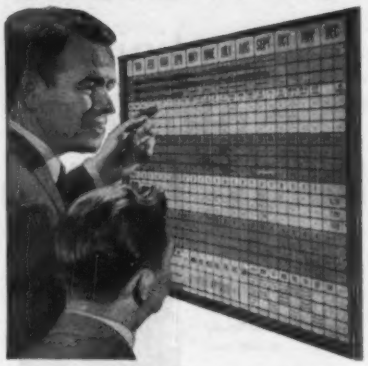

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realization without mutual inductance but requiring a larger number of elements.

Certain esoteric considerations relating to applications and network construction are dealt with in chapters 11 and 12.

Approximation Techniques—The remaining chapters are concerned with approximation techniques for evolving realizable functions whose frequency behaviors are acceptably close to requirements. The author explores a variety of techniques, such as, trial and error attacks, method of least squares, the Taylor approximation, Padé procedure, Chebyshev polynomials, the use of weighting functions and practical difficulties which may arise in selecting an optimum approximation.

The analogy between complex-variable theory and two-dimensional potential theory is fully exploited from basic considerations of potential functions. Usable results are derived and applied to approximating a constant. Further extensions will be covered in Volume II.

The last chapter presents a review of developed principles and applies them to a few unifying examples. It is followed by three appendices. The last contains a bibliography which is very much up to date.

Throughout the book, the author makes a very strong attempt to hold the reader's attention by interjecting challenging remarks and by providing concise summaries, conclusions, discussions, reviews, recapitulations, and retrospects at strategic locations. The treatment is rather lucid and revealing. However, there is no pretense of completeness even though the book is quite large. As a whole, it will prove to be an excellent addition to the literature and should enjoy wide acceptance. —ANTHONY B. GIORDANO, *Polytechnic Institute of Brooklyn, Brooklyn, N. Y.*

THUMBNAIL REVIEWS

Vorschaltgeraete and Schaltungen fur Leuchstofflampen. By C. Sturm; Brown Boveri & Cie AG., Mannheim, Germany, 1957, 372 p. This worthy pocket-size handbook covers almost every aspect of fluorescent lamp characteristics and applications

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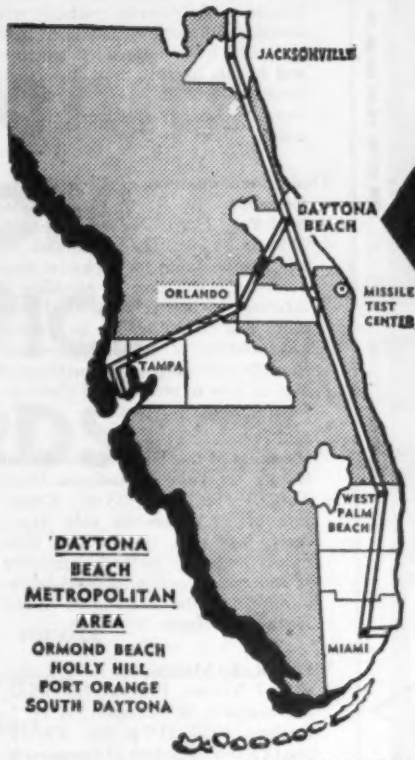

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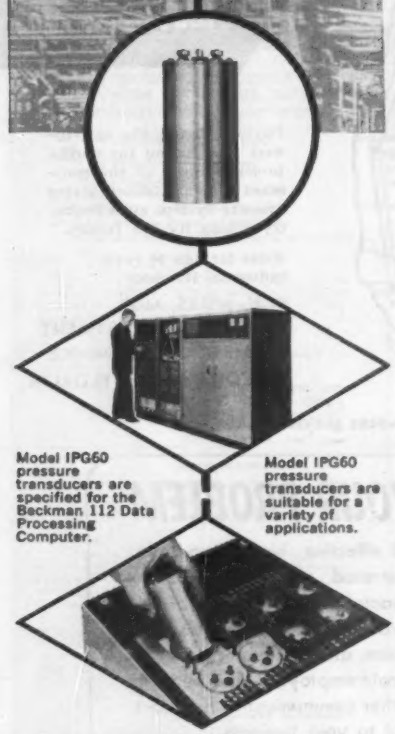

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including starting arrangements, stabilization, brightness control, economic considerations, fading of dyed materials from ultraviolet radiation and health hazards from fluorescent sources. References are included to Swiss, German and American trade and technical literature.

Oral Communication of Technical Information. By R. S. Casey, Reinhold Pub. Corp., New York, 1958, 199 p. $4.50. This handbook on effective speaking for technical men covers such situations as presiding at meetings, giving technical legal testimony and talking science to laymen. Organization of material, composition, delivery and use of mechanical aids such as recordings and slides are treated.

Proceedings of the Third National Conference on Tube Techniques. New York, 1958, 128 p, $5.00. Collection of 29 papers on tube types, parts, materials, production techniques and test methods presented at conference sponsored by Advisory Group on Tube Techniques of the Dept. of Defense.

V.H.F. Radio Manual. By P. R. Keller, George Newnes, Ltd., Tower House, Southampton St., London, W.C. 2, England, 1957, 216 p, 30s. Theory, practice and operation of commercial and amateur vhf two-way radio systems, f-m broadcasting transmitters and receivers, and tv tuners operating in the 30 to 450-mc range. Information available in basic radio textbooks is not repeated except where it is necessary to maintain the self-contained nature of the book. Physical significance of mathematical expressions is explained by diagrams or graphs.

Television in Science and Industry. By V. K. Zworykin, E. G. Ramberg and L. E. Flory, John Wiley & Sons, Inc., New York, 1958, 300 p, $10.00. This book is devoted mainly to achievements in the applications of closed-circuit television systems. Individual chapters cover the history of the medium and the equipment developed for it.

Methods of Testing Thermocouples and Thermocouple Materials—NBS Circular 590. By Wm. Roeser and S. T. Lonberger, Superintendent of Documents, U.S. Printing Office, Washington 25, D.C., 1958, 21 p, $.20. Calibration of platinum vs platinum-rhodium, copper-constantan, Chromel-Alumel and iron-constantan thermocouples is covered along with guidance on selection of best test method for particular circumstances. Accuracies obtained in calibrating various thermocouples by different methods, along with the uncertainty in the interpolated values by various methods, are presented in a table.

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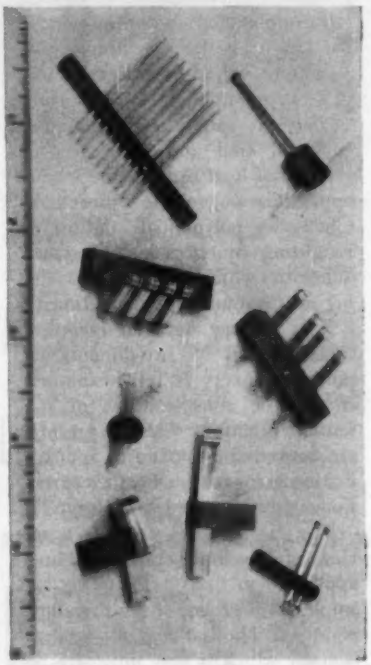

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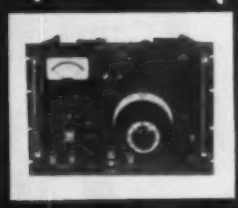

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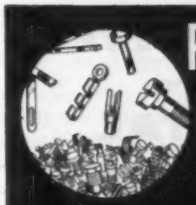

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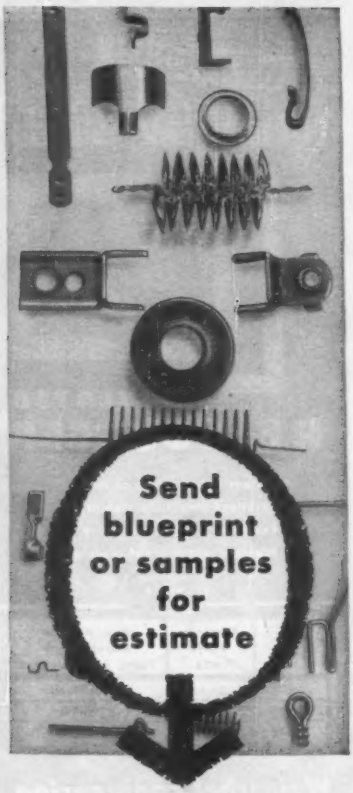

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COMMENT

Radar Power

. . . "Radar Power Nomograph" (July 4, p 72) . . . gives relationships for computing the power per square centimeter close to radar antennas. I wish to point out that these relationships are valid only in the Fraunhofer region (far field). Accordingly, for radars in current use the distances from the antenna in the nomograph would lead to incorrect results since the Fresnel zone (near field) can be considered to end at a distance from the aperture equal to the square of the diameter of the reflector divided by twice the wavelength.

Thus the end of the near field for a 3-cm set with a 3-ft antenna would be 45 ft, and a 10-ft antenna, 511 ft; for a 10-cm set with an 8-ft antenna, 100 ft, and a 32-ft antenna, 1,600 ft; for a 30-cm set with a 50-ft antenna, 454 ft.

From the above we see that the nomograph cannot be used for most practical . . . radar installations. In the near field, a good approximation is to divide the average power by the cross-sectional area of the antenna in centimeters, since there is no beam-spreading in the Fresnel zone.

JOSEPH H. VOGELMAN
ROME AIR DEVELOPMENT CENTER
ROME, N. Y.

. . . I have measured greater field strengths at the fundamental frequency in front of a hangar when the main beam was directed between two hangars than I did in the center of the beam at a distance of 2,500 ft from the antenna. This effect was caused by multiple reflections from the hangar wall . . .

HARRY R. MEAHL
GENERAL ELECTRIC CO.
SCHENECTADY, N. Y.

Author Allen agreed that Reader Vogelman's observation was correct, adding:

However, the intended use of the nomograph was as a quick method of determining density levels by nontechnical persons such as safety or laboratory supervisors. Appropriate to this purpose, the nomograph gives conservative an-

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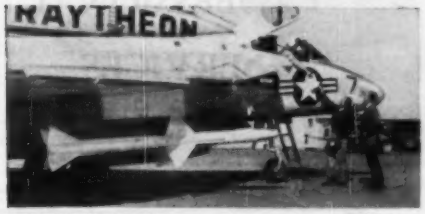

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swers insofar as safety is concerned over a range from the antenna to about 1½ times the extension of the near field as determined from $D^2/2\lambda$.

The nomograph was developed for use at Air Arm division (of Westinghouse Electric) where we are primarily concerned with airborne X-band antennas. If it is applied to ground or shipboard radars having very high power or very large antennas, or both, the indicated densities in the near field may be so conservatively estimated that shielding for personnel would appear impractical. In such circumstances, use of the near-field equation would be more suitable.

In reply to Reader Meahl's comment, Author Allen wrote:

. . . We have experienced phenomena similar to that which you described in making measurements in the vicinity of radar antennas. My original manuscript had several cautions in it concerning sidelobes, noncircular main beams, reflections and multiple installations, but these were (subsequently) edited out of the article . . .

J. E. Allen
Westinghouse Electric
Baltimore, Md.

Intermetallics

In regard to our article on indium antimonide detectors ("New Intermetallics Offer Wide Infrared Response," July 4, p 48) . . . because of uncorrected editorial changes, the article as published contains typographical errors, redundancies, meaningless statements and incorrect organization . . .

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Project Engineer Robert J. Cantwell (left) uses a system of gimbals to describe navigational problems in the analysis of a new system design.

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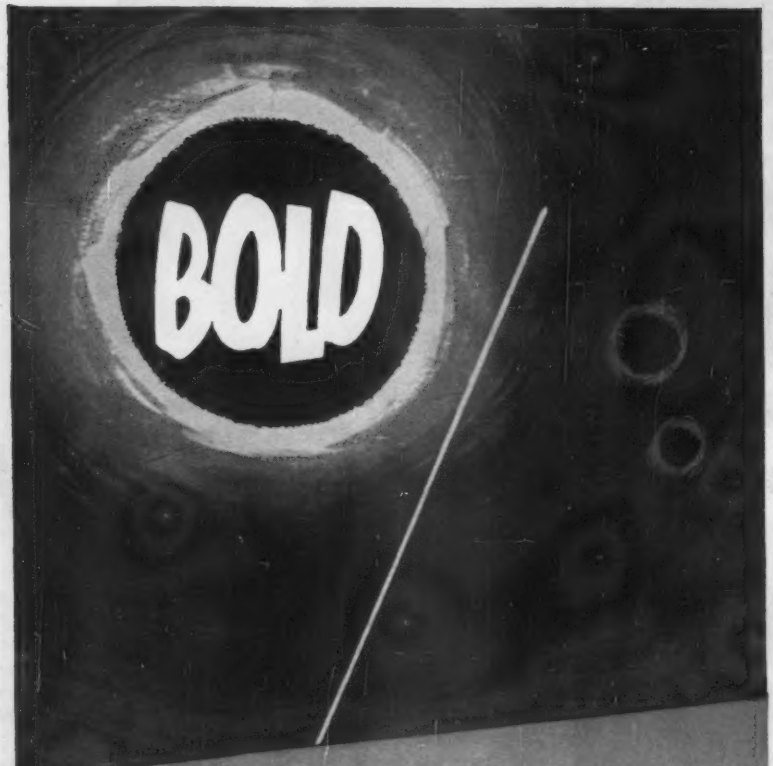

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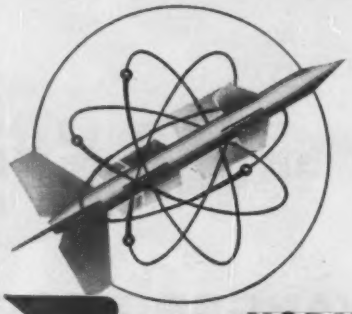

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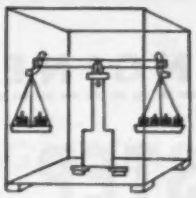

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(Continued on pages 202-205)

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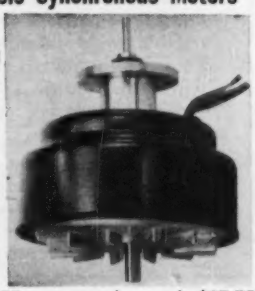

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TR4001 @ 1 Amp† ea/sec/w	$5.15
TR4002 @ 2 Amp† ea/sec/w	7.15
TR4003 @ 5 Amp† ea/sec/w	9.00
TR4005 @ 12 Amp† ea/sec/w	17.60
TR4006 @ 24 Amp† ea/sec/w	35.60
TR4007 @ 50 Amp† per ea sec wnds	58.45
TR4008 @ 100 Amp† per ea sec wnds	117.00

*Windgs in Series at Ratings shown: Parallel 2X Current, Voltage output, 0-9-18-18.
*Dual Pri 115 & 230VAC/60cys Input.

"TABTRAN" Rectifier Chokes

CR6001/ 1 Amp/0.1 HY/1.4 Ohm	$1.90
CR6002/ 2 Amp/0.1 HY/.07 Ohm	2.75
CR6003/ 5 Amp/.07 HY/.6 Ohm	9.90
CR6004/12 Amp/.01 HY/.1 Ohm	15.75
CR6005/24 Amp/.004 HY/.025 Ohm	29.60
CR6006/50 Amp/.001 HY/.001 Ohm	47.00

FILTER CAPACITORS

CE156M 6000MFD 15V	$2@
CE502M 2000MFD 30V	$4@
CE2005M 500MFD @ 200V	$5@
Brackets for Capacitors @ 25c each	

New Variable Voltage X-frms

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0-132v-1.25A	$7.23
0-135V/3A	10.63
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Uncased/0-135V/7.5A	15.30
Cased/0-270V/3A	22.10
Uncased/0-270V/3A	17.90
Cased/0-135V/15A	39.10
Cased/0-270/9A	39.10
Uncased 0-135V@30A	44.10
Uncased 0-270V@12A	44.10
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SUBMINIATURE CAPS
VACUUM CAPS. Prices quoted.

TYPE "J" POTS

"JU" Linear Taper	$ .75
"JLU" Linear Taper	$ .85
"JJ" Linear Taper	$2.50

Mfd	Volts	Price
.001	10KV	4.95
.001	50KV	24.95
.0025	10KV	5.25
.0025	15KV	6.95
.005	25KV	21.95
.01	1500	.55
.012	25KV	10.95
.015	16KV	12.95
.02	8000	4.50
.02	10KV	5.25
.02	20KV	8.25
.025	15KV	7.25
.025	50KV	32.95
.03	7500	4.25
.04	17KV	6.50
.05	2500	.65
.05	7500	4.50
.05	16KV	7.95
.05-.05	12KV	8.95
.05-.05	40KV	68.00
.075	7000	3.25
.1	1500	.25
.1	2000	.65
.1	2500	.69
.1	3000	.50
.1	3000	1.19
.1	4000	1.29
.1	5000	1.30
.1	5000	3.25
.1	7500	.89
.1	7500	1.95
.1	12KV	6.95
.1	15KV	8.95
.1	20KV	9.95
.1	25KV	24.95
.125	27.5	21.95
.125	100KV	PUR
.1-.1	7000	1.35
.2	10KV	8.50
.2	15KV	9.50
.2	20KV	10.75
.2	50KV	69.50
.25	2000	.89
.25	3000	1.25
.25	4000	1.75
.25	6000	.89
.25	15KV	15.95
.25	20KV	19.95
.25	25KV	49.50
.25	50KV	69.50
.3	2000	.25
.4	10KV	10.95
.4-.4	7500	3.75
.5	440VAC	.49
.5	600	.45
.5	1500	.59
.5	2000	1.19
.5	2500	1.21
.5	3000	1.25
.5	4000	1.95
.5	4000	6.50
.5	8000	30.50
.5	15KV	15.95
.5	20KV	19.95
.5	25KV	49.50
.5	50KV	69.50
.5	600	.25
.5	1000	.24
.5	1000	.39
.5	2500	.34
.5	3000	4.95
.5	3000	6.99
.5	4000	18.50
.5	5000	19.95
.5	7500	59.50
.5	600	.35
.5	600	.49
.5	680	.29
.5	680	.35
.5	680	.49
.5	680	.89
.5	680	.15
.5	680	.32
.5	680	.49
.5	3000	1.25
.5	4000	3.25
.5	5000	3.95
.5	7500	4.95
.5	9000	5.95
.5-.5	9000	5.95
.5-1	2000	.32
1-115	VAC	
1	600	.44
1	1000	.69
1	1500	.99
1	2000	1.55
1	3000	2.55
1	3600	2.75
1	4000	4.95
1	5000	6.25
1	6000	8.95
1	7500	7.50
1	7500	14.75
1	10KV	22.95
1	12.5KV	32.95
1	15KV	38.50
1	16KV	37.50
1	20KV	49.95
1	25KV	59.50
1	25KV	69.50
1.25	330VAC	.49
1.5	15KV	45.00
1.5	25KV	PUR
2	600	.55
2	1000	.79
2	1000TLA	1.29
2	1500	1.15
2	2000	2.75
2	2500	3.25
2	3000	4.95
2	4000	7.75
2	5000	11.50
2	6000	21.95
2	7500	23.50
2	10KV	55.00
2	12.5	33.50
3	1000	.99
3	2000	1.95
3	8000	30.50
4	500	.65
4	600	.75
4	600TLA	.89
4	330VAC	1.25
4	1000	1.10
4	1000	1.69
4	1500	2.65
4	2000	3.75
4	3000	6.99
4	4000	18.50
4	5000	19.95
4	7500	59.50
3x.1	400	.15
3x.1	600	.33
.2	1000	.19
.25	400	.25
.25	600	.29
.25	1000	.39
2x.25	400	.34
2x.25	600	.24
2x.25	1000	.49
.5	400	.29
.5	600	.35
2x.5	600	.49
3x.1	400	.12
3x.1	600	.35
.25	400	.19
.25	600	.19
2x.25	600	.25
2x25	600	.35
.5	400	.89
.5	580	.15
.5	680	.32
2x.5	600	.49
4	10KV	74.50
4	15KV	PUR
5	220VAC	.98
5	330VAC	1.19
5	600	.95
5	1000	1.69
5-5	400	.89
6	330VAC	1.25
6	600	1.29
6	1000	1.95
6	1500	2.95
7	600	1.15
7	800	1.25
8	330VAC	1.50
8	600	1.29
8	660VAC	2.49
8	1000	2.15
8	1500	1.65
8	2000	6.95
8	9500*	19.50
8-8	600	1.89
3x8	600	2.25
4x8	600	2.98
9	10KV	PUR
10	400	.65
10	600	1.10
10	600	1.49
10	1000	3.45
10	1400	2.25
10	1500	4.35
10	2000	4.50
10	2500	10.95
10	2500*	6.25
10	4000	20.95
10	5000	PUR
10	6000	52.50
12	660VAC	4.25
12	1000	2.95
12	2000	7.75
13.5	4000	21.25
14	660VAC	4.25
15	440VAC	3.25
15	600	2.95
15	1000	4.10
15	1500	6.35
15	5000	PUR
20	330VAC	3.25
20	4000V	35.25
25	600	4.25
25	2500*	18.95
28	1000	5.50
30	2500	13.50
32	600	2.98
40	600	5.85
50	100	4.10
50	330VAC	6.50
100	4000	49.50
120	3000	49.25

* Photo Flash

BATHTUB CONDENSERS

Mfd	Volts	Price
.01	600	.19
2x.01	600	.15
2x.02	600	.15
2x.025	600	.15
2x.04	600	.15
.05	1000	.24
2x.08	600	.12
.1	600	.25
2x.1	600	.19
.1	1200	.35
.1	1500	.39
2x.1	1000	.35
3x.1	400	.15
3x.1	400	.15
.2	1000	.19
.25	400	.25
.25	600	.29
.25	1000	.39
2x.25	400	.34
2x.25	600	.24
2x.25	1000	.49
.5	400	.29
.5	600	.35
2x.5	600	.49
3x.5	400	.40
1	300	.29
1	400	.35
1	600	.45
1	1000	.55
2x1	600	.69
2	50	.30
2	400	.49
2	600	.59
2x2	200	.35
4	100	.59
4	400	.79
6	150	.70

CHANNEL CONDENSERS

Mfd	Volts	Price
.007	1000	.15
.01	600	.21
.01	1000	.27
2x.01	1000	.33
.05	600	.19
.05	1000	.29
2x.05	600	.29
3x.05	600	.35
.1	580	.22
.1	1000	.35
2x.1	600	.31
.1	1000	.39
.1	1000	.49
.1	1200	.49
.1	1500	.49
.1	2000	.49
.2	1000	.49
.25	600	.49
.25	1000	.49
.25	1200	.49
.25	1500	.49
.25	2000	.49
.5	600	.49
.5	1000	.49
.5	1200	.49
.5	1500	.49
.5	2000	.49
.5	2500	.49
.5	3000	.49
.5	4000	.49
.5	5000	.49
.5	6000	.49
.5	7500	.49
1	600	.49
1	1000	.49
1	1200	.49
1	1500	.49
1	2000	.49
1	2500	.49
1	3000	.49
1	4000	.49
1	5000	.49
1	6000	.49
1	7500	.49
2	600	.49
2	1000	.49
2	1200	.49
2	1500	.49
2	2000	.49
2	2500	.49
2	3000	.49
2	4000	.49
2	5000	.49
2	6000	.49
2	7500	.49
3	600	.49
3	1000	.49
3	1200	.49
3	1500	.49
3	2000	.49
3	2500	.49
3	3000	.49
3	4000	.49
3	5000	.49
3	6000	.49
3	7500	.49
4	600	.49
4	1000	.49
4	1200	.49
4	1500	.49
4	2000	.49
4	2500	.49
4	3000	.49
4	4000	.49
4	5000	.49
4	6000	.49
4	7500	.49

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115 VAC 60 Cycle COMPACT TYPE—108 CFM; Motor build inside squirrel cage; 4⅛" intake, 3⅝" x 3" Dia. Complete size: 4⅛" W x 8⅝" H x 8⅛" D. No. 2C967B.....$15.95

115 VAC 60 Cycle FLANGE TYPE—140 CFM; 3½" intake 2½" Dia. Complete size: 7½" x 7¼" H x 6⅜" D. No. 1C807B.....$14.95

115 VAC 60 Cycle FLANGE TWIN—275 CFM; 4½" intake, 3¼" x 3" Dia. Complete size: 11⅜" W x 8⅜" H x 8 1/16" D. No. 2C965B.....$22.95

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Motor Only.....$2.95

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Motor Only.....$2.95

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Motor Only.....$2.95

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12117 Bendix
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12121 Bendix
Input: 24 volt D.C. 18 amp. 12000 r.p.m. Output: 115 volts, 400 cycle, 3-phase. 250 volt amp, 7 pf. **$49.50**

12123 Bendix
Output: 115 V, 3 phase; 400 cycle; amps. .5; Input: 24 VDC; 12 amp. **$49.50**

12126-2-A Bendix
Output: 26 volts; 3 phase; 400 cycle; 10 VA; 6 PF. Input: 27.5 volts DC; 1.25 amps. **$24.50**

12142-1-A Bendix
Output: 115 volts, 3 phase, 400 cycle, 250 VA. Input: 27.5 VDC, 22 amps. Voltage and frequency regulated. **$99.50**

12147-1 Pioneer
Output: 115 VAC, 400 cycles; single phase. Input: 24-30 VDC; 8 amps. **$19.95 each**

10285 Leland
Output: 115 volts AC, 750 VA, 3 phase, 400 cycle, .90 pf and 26 volts. 50 VA single phase, 400 cycle, .40 pf. Input: 27.5 VDC, 60 amps. cont. duty, 6000 rpm. Voltage and frequency regulated. **$59.50**

10563 Leland
Output: 115 VAC; 400 cycle; 3-phase; 115 VA; 75 pf. Input: 28.5 VDC; 12 amps. **$25.00**

PE109 Leland
Output: 115 VAC, 400 cyc.; single phase; 1.53 amp.; 8000 rpm. Input: 13.5 VDC; 29 amp. **$50 00**

PE218 Leland
Output: 115 VAC; single phase pf. 90; 380/500 cycle; 1500 VA. Input: 25-28 VDC; 92 amps.; 8000 rpm.; Exc. Volts 27.5 **$30.00**

AN 3499 Eicor, Class "A"
Input: 27.5 volts at 9.2 amps. AC. Output: 115 volts, 400 cycles; 3 phase, 100 voltamp; continuous duty. **Price $39.50 each**

MG54D BENDIX INVERTER
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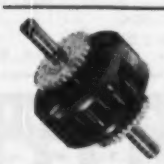
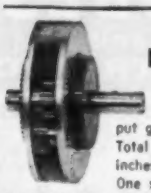
Output: 200/115 volts; 400 cycle, single or 3 phase; .80 pf, 250 VA. Input: 28 VDC, 22 amps. **$99.50**



DIFFERENTIAL

Size 2⅛" long, 1⅛" dia. 1-1 reverse ratio. ¼" shaft on each end; one shaft 25/32" long, one shaft 15/32" long. Input and output gear 1-23.32" dia. 53 teeth. Stock No. 150 **$3.50 ea.**



SIMPLE DIFFERENTIAL

1 to 1 reverse ratio; 48 teeth on input and output gear, 1-1/32 inch diameter. Total outside diameter 1-25/32 inches. Shaft size is ¼ inch. One shaft is 9/16" long; other shaft is 3/16" long.

Stock No. 151 **$5.00**

ONAN MOTOR GENERATOR SET
MG 075-G-1

Generator 115 VAC; 480 cycle; 5.3 amps; .6KW; PF 1.0; Also 26 VDC; 100 watt; 3.8 Amps; Driven by 115-230 VAC —2hp motor; 60 cycle; single phase; 3450 rpm; 10.5 amps.

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1DG Diff. Gen. 90/90V 60 cy.	34.50
1F Syn. Mtr. 115/90V 60 cy.	34.50
1G Gen. 115V 60 cy.	34.50
1HDG	37.50
1HCT	37.50
1HG	37.50
1SF Syn. Mtr. 115/90V 400 cy.	12.50
23TR6 torque receiver, 115/90 VAC, 60 cycle	37.50
23CT6 control transformer, 90/1V per degree, 60 cycle	37.50
23CX6 control transmitter, 115/90 VAC, 60 cycle	37.50
7DG differential generator, 90/90 volts, 60 cycle	37.50
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2J1FA1 Gen. 115/57.5V 400 cy.	7.50
2J1G1 57.5/57.5V 400 cy.	5.00
2J1H1 Diff. Gen. 57.5V 400 cy.	7.50
2J5D1 Cont. Trans. 105/55V 60 cy.	17.50
2J5F1 Cont. Trans. 105/55V 60 cy.	17.50
2J5H1 Gen. 115/105V 60 cy.	17.50
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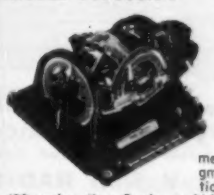
5D Diff. Mtr. 90/90V 60 cy.	34.50
5DG Diff. Gen. 90/90V 60 cy.	34.50
5F Syn. Mtr. 115/90VAC 60 cy.	34.50
5G Syn. Gen. 115/90VAC 60 cy.	34.50
5HCT Cont. Trans. 90/55V 60 cy.	37.50
5SDG Diff. Gen. 90/90V 400 cy.	12.50
6DG Diff. Gen. 90/90V 60 cy.	25.00
6G Syn. Gen. 115/90VAC 60 cy.	34.50
7G Syn. Gen. 115/90VAC 60 cy.	42.50
C56701 Type 11-4 Rep. 115V 60 cy.	20.00
C69405-2 Type 1-1 Transm. 115V 60 cy.	20.00
C69406 Syn. Transm. 115V 60 cy.	20.00
C69406-1 Type 11-2 Rep. 115V 60 cy.	20.00
C76166 Volt. Rec. 115V 60 cy.	10.00
C78248 Syn. Transm. 115V 60 cy.	12.50
C78249 Syn. Diff. 115V 60 cy.	5.00
C78410 Repeater 115V 60 cy.	20.00
C78863 Repeater 115V 60 cy.	7.50
C79331 Transm. Type 1-4 115V 60 cy.	20.00
851 Bendix Autosyn Mtr. 22V 60 cy.	7.50
403 Kollsman Autosyn. Mtr. 32V 60 cy.	7.50
FPE-25-11 Diehl Servo Mtr. 75/115V 60 cy.	15.00
FPE-43-1 Resolver 400 cy.	19.50
FJE-43-9 Resolver 115V 400 cy.	15.00

HONEYWELL VERTICAL GYRO MODEL JG7003A-1



115 volts, 400 cycles, single phase, 35 watts. Pitch and roll Potentiometer pickoffs 890 ohms, 40 volts max. AC or DC. Speed 20,000 rpm, ang. momentum 12,500,000 gm-cm ²/sec. Erection system 27 VAC, 400 cycles, time 5 min. to ½°. Weight 5.5 lbs.

Price **$35.00** each

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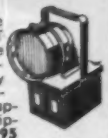
5" Schmidt Ultra Hi-Speed Objective Lens System



Eastman Kodak infra-red receiver, formerly known as U.S. Navy Metascope, Type B, 7" long with 5" SCHMIDT ultra-high speed Objective Lens (approx. f 0.5). Elaborate optical system, many coated lenses. Uses 2 penlight batteries. Govt. cost approx. $300. Factory-new. Shipping wt. 9 lbs. Price **$19.95**

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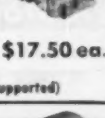

Forward & Reverse 4-0-4. Input shaft 5/16" dia. x ¾" long. Output shaft 15/64" dia. x 9/16" long. Control shaft 11/64" dia. x 11/16" long. Cast aluminum construction. Approx. size 4½" x 4½" x 4".

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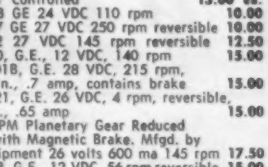

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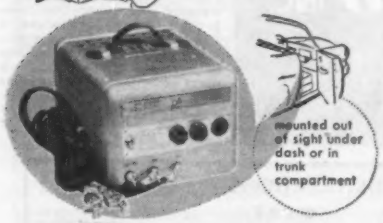

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- Independent of voltage phase relation
- Accuracy unaffected by reference voltage stability
- Ideal instrument for measurements of response and gain characteristics of passive and active networks: filters, precision transformers, attenuators, amplifiers, transformer ratios
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SPECIFICATIONS

Percent Difference: −10% to +5% in .01% increments on multiturn potentiometer dial.
Input Voltage (each channel): .3 volt to 100 volts rms in 5 ranges.
Input Impedance: 470 K ohms shunted by approximately 20 mmf capacitance on 1 volt range; 400 K ohms shunted by 40 mmf.
Frequency Range: 20 to 20,000 cps (MODEL 1560); 20 to 200,000 cps (MODEL 1560E).
Calibration Linearity: ±.25% difference, 20 to 20kc; ±.5% difference, 20 to 200kc.
Power Supply: Electronically regulated; 115 volts, 60 cps input.

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AND ACCESSORIES

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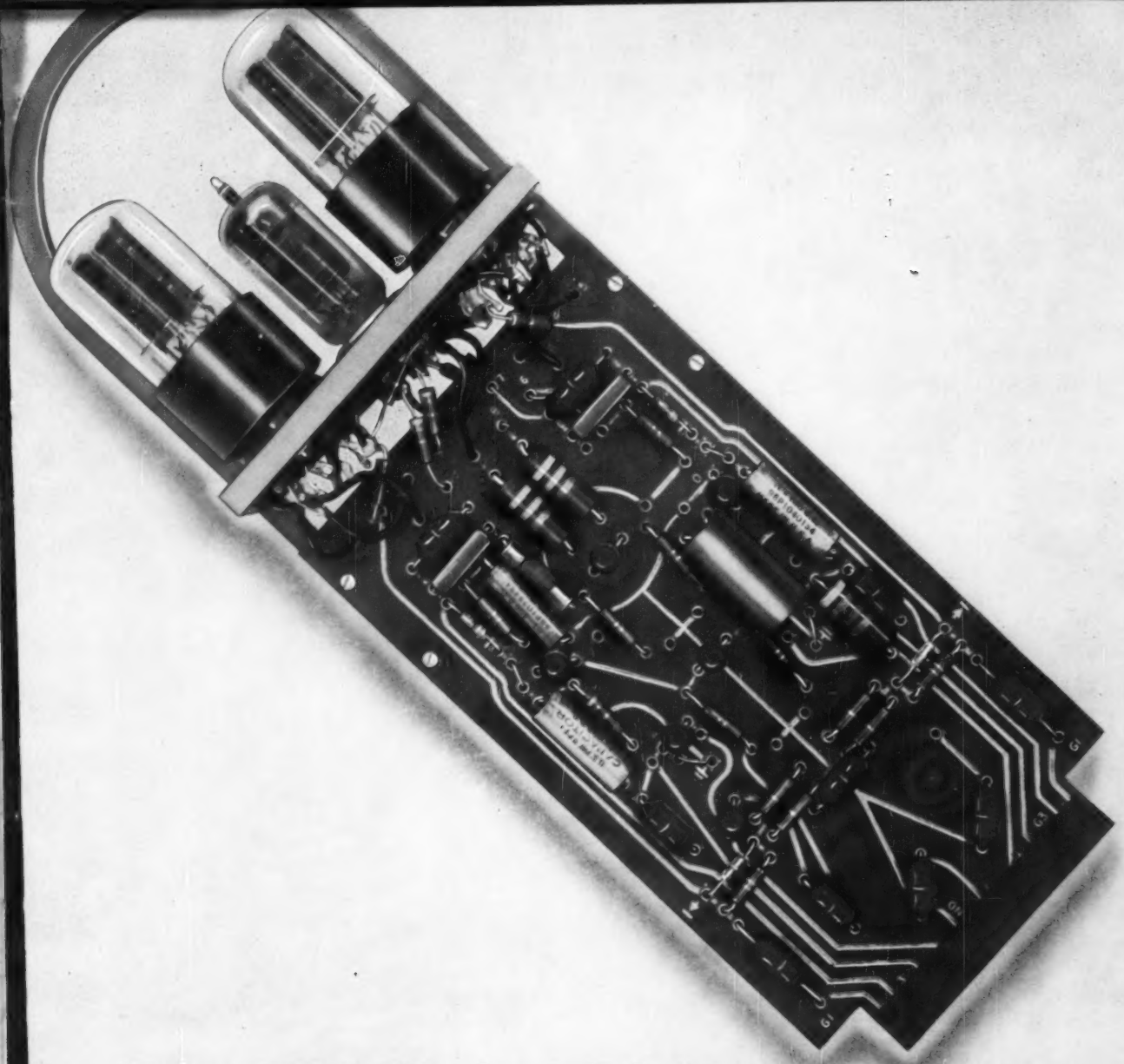

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